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Engineers, Architects, Planners,
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Open File Report 86-8

STUDY OF MARKETS FOR SILICA AND SILICA SANDS ACCESSIBLE FROM NOVA SCOTIA AND NEW BRUNSWICK

by

ADI LIMITED

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STUDY OF MARKETS

FOR SILICA AND SILICA SANDS

ACCESSIBLE FROM

NOVA SCOTIA AND NEW BRUNSWICK

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ADI LIMITED
FREDERICTON, N. B.
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Management Consultants, Surveyors

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EXECUTIVE SUMMARY

Silica and silica sands are consumed by a wide variety of industries for diverse purposes. New Brunswick and Nova Scotia each have one silica sand operation currently in production. Given favourable marketing environment, there appears to be potential to expand sand and lump silica production in both provinces.

Assuming that product specifications can be met or exceeded, the two critical marketing variables are cost/price and demand. Production costs are very difficult to establish, as they are dependent upon such factors as silica type, quality, location, beneficiation requirements, etc. A review of industry literature reveals that a New Brunswick or Nova Scotia producer could experience costs varying from $8.00 to $20.00 per tonne. In addition, transportation costs are very high, often exceeding estimated production costs.

Price information is more readily available; silica price being dependent upon silica quality, the quantity purchased, and distance from the source. A market analysis reveals that price can vary from $10.00 to $100.00 per tonne.

Canada annually imports approximately one million tonnes of high quality silica sand from the United States, while quartzite is exported to the United States, albeit in small quantities. Most of the imported sand is consumed by the glass, foundry, silicon carbide and silicon metal industries of Quebec and Ontario. Market analysis suggests that the sand imports could be targetted for competition and partially replaced by silica sand from Nova Scotia and New Brunswick. Potential "exports" to Quebec and Ontario, based on 10 percent of market share, might be 100 000 to 150 000 tonnes per annum.

The United States market appears to be less attractive, and limited only to those Atlantic states north of New Jersey. Potential exports of silica sand, again based on 10 percent of market share, is estimated to be only 25 000 tonnes per annum.

The aforementioned high transportation costs render exports to most other large foreign consumers uneconomic. However, the possibility exists that exports of lump silica to Norway or, conceivably, Iceland, might be feasible. Norway, for example, presently imports up to 400 000 tonnes of quartzite, principally from Spain.

In summary, there presently exists a demand for silica sand which could be met competitively and profitably by producers from Nova Scotia and New Brunswick. The lump silica market appears to be less certain.

Looking into the future, trends are both positive and negative for Maritime suppliers. On the supply side, several trends (land use conflicts, environmental constraints) point towards a positive market. However, development of a large, new deposit could affect a Maritime supplier very negatively. On the demand side, both negative and positive trends are apparent. Several large silica-consuming industries (glass containers, foundries) face uncertain futures; however, several new silica-consuming industries (fibre optics, solar energy applications, ceramics) face bright prospects.

Determining the effects of these trends is difficult, but it appears that in the short-term (until 1989) silica demand will grow by 2.1 percent per year in the United States and 0.06 percent per year in Canada. For the long-term (until 2005) the American silica market will grow by 1.7 percent per year and the Canadian market by 1.4 percent per year.

To summarize, if a Maritime supplier can meet quality and cost standards, he should be able to obtain and maintain market share in the Quebec and, perhaps, Ontario and American northeast markets.

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1. INTRODUCTION

ADI Limited was retained by Supply and Services Canada on behalf of Energy, Mines and Resources, to carry out an in-depth study to determine and quantify markets for silica and silica sands reasonably accessible from Nova Scotia and New Brunswick.

The scope of work and other background material presented in the original Terms of Reference are given in Appendix 1. Briefly, the approach was first to identify silica and silica sands consumers by industry, noting specifications required, quantities used, current suppliers, prices paid, transportation costs, etc., and then to identify opportunities for potential market penetration. These aspects are addressed in this Phase 1 report. A subsequent Phase 2 report will present the results of our analysis into the demand for silica and silica sands within the study area by consumer-industry to the year 2005, and our estimate of the reserves of present suppliers.

It became clear that while the prime objective was to identify market opportunities rather than to make an inventory of silica resources, such an inventory would be required as part of the market analysis. The silica specification requirements for some end uses preclude the utilization of anything other than the highest quality silica material. Furthermore, some industries consume only silica sands; others only the coarser "lump silica" sizes. Accordingly, for both New Brunswick and Nova Scotia, we have listed known and potential silica and silica sands resources, together with their physical and chemical characteristics. The list may not be exhaustive, but we believe that the major silica deposits in the region have been identified. Not all of these deposits could be feasibly developed, as the market study will demonstrate.

Although silica and silica sands are higher in value than mineral aggregates, transportation costs from producer to consumer often exceed the product cost at the pit or quarry. Transportation aspects of this study are therefore of paramount importance.

2. USES AND SPECIFICATIONS

2.1 General

Silica and silica sands are used in a wide variety of industries for diverse purposes. In Canada, the principal uses for silica are for foundry sand, glass manufacture and smelter flux; these uses together represent approximately 70-80 percent of national silica consumption. In the United States, use for silica as smelter flux is relatively limited; glass and foundry sand together represent 50-60 percent of U.S. consumption, while blasting sand and sand for hydraulic fracturing are rated third and fourth respectively, together making up another 10 percent of U.S. consumption.

Table 2.1 gives the quantity of industrial sand and gravel sold or used by U.S. producers for the year 1983, broken down on an industry-by-industry basis. Since the patterns of silica use fluctuate significantly from year to year depending on economic and other factors, such a table should be interpreted with caution. Nevertheless, it serves as a list of major silica and silica sand uses. Several commodities derived from silica have uses in a variety of industries. Silicon carbide, for example, is an important abrasive and refractory material in addition to it having the metallurgical applications noted in Table 2.1.

Two categories of silica are identified in Table 2.1; these being "sand" and "gravel". "Sand" refers to the smaller grain sizes, typically less than 5 mm in diameter, while the term "gravel", often referred to as "lump silica", is reserved for coarser particles including those derived from both natural gravel deposits and from crushed quartzites, quartz veins, etc. In addition to particle size, chemical purity of the silica is of great importance in most consumptive uses. Silica specifications for the major industries are briefly presented and discussed below.

TABLE 2.1

INDUSTRIAL SAND AND GRAVEL SOLD OR USED BY U.S. PRODUCERS, BY MAJOR USE, 1983 (Ref. 2.1)

Major Use	Quantity (x 1000 short tons)	Value (x 1000 US$)	Value US$/ton
Sand:			
Glassmaking:			
Containers	6 847	79 935	11.67
Flat (plate and window)	960	10 965	11.42
Specialty	558	7 449	13.35
Fiberglass (unground)	524	6 457	12.32
Fiberglass (ground)	547	12 007	21.95
Foundry:			
Molding and core	6 428	54 952	8.55
Mold and core facings (ground)	51	1 625	31.86
Refractory	191	2 898	15.17
Metallurgical:			
Silicon carbide	94	912	9.70
Flux for metal smelting	74	702	9.49
Abrasives:			
Blasting	1 785	28 411	15.92
Scouring cleansers (ground)	165	3 769	22.84
Sawing and sanding	W	W	32.00
Chemicals (ground and unground):	271	3 400	12.55
Fillers (ground):			
Rubber, paints, putty, etc.	141	7 693	54.56
Ceramic (ground):			
Pottery, brick, tile, etc.	179	6 067	33.89
Filtration	102	1 422	13.94
Traction (engine)	195	2 398	12.30
Coal washing	W	W	11.80
Roofing granules and fillers	296	3 778	12.76
Hydraulic fracturing	990	22 376	22.60
Miscellaneous uses	286	3 002	10.50
Total or average	26 080	329 500	12.64
Gravel: Metallurgical:			
Silicon, ferrosilicon	267	2 441	9.14
Filtration	57	1 149	20.16
Grinding	W	W	W
Total or average	537	5 667	10.55
Grand total or average	26 620	335 200	12.59

2.2 Glass (Sand)

High purity naturally-occurring sand or crushed quartzite/quartz/sandstone is used in the manufacture of glass. In addition to the typical requirements for glass sand given in Table 2.2 below, even minor quantities of elements such as chromium (maximum permissible concentration 6 ppm) and cobalt (<2 ppm) act as powerful colourants and are therefore particularly objectionable.

Table 2.3 gives the minimum specifications required to be met by prospective suppliers of silica sand to Domglas Ltd. glass plants in New Brunswick and Quebec.

Chemical specifications for sand used in the manufacture of fiberglass are less stringent than those for coloured glass. Physical requirements are similar to those for glass sand, with emphasis on the finer fractions, but still above 100 mesh.

2.3 Foundry (Sand)

Naturally occurring sand or material produced by crushing friable sandstone is used in the foundry industry for moulding. For foundry purposes, the chemical composition of the sand is not as important as its physical properties. For the end-use, a highly refractory sand, having rounded grains with frosted or pitted surfaces is preferred. Grain sizes vary between 20 and 200 mesh. Rounded grains are preferable to angular fragments because they allow maximum escape of gas during casting.

Typical specification requirements for foundry sand are given in Table 2.4 (page 2.6).

TABLE 2.2

SPECIFICATIONS FOR SILICA SANDS - GLASS INDUSTRY
(Ref. 2.2 and 2.3)

Quality	Type	SiO_2 Min.	Al_2O_3 Max.	Fe_2O_3 Max.	CaO+MgO Max.		Grain Size/ Shape
1.	Optical	99.8	0.1	0.02	0.10	]	
2.	Flint, tableware	98.5	0.5	0.035	0.2	]	
3.	Flint	95.0	4.0	0.035	0.5	]	
4.	Sheet and rolled	98.5	0.5	0.06	0.5	]	0.2-0.5 mm
5.	Sheet and rolled	95.0	4.0	0.06	0.5	]	
6.	Green and window	98.0	0.5	0.3	0.5	]	
7.	Green	95.0	4.0	0.3	0.5	]	
8.	Amber	98.0	0.5	1.0	0.5	]	
9.	Amber	95.0	4.0	1.0	0.5	]	
					Max. CaO	Max. MgO	
Glass wool		30-60	3-12	<4.0	20-40	2-10	0.07 - 0.08 mm

TABLE 2.3

NOMINAL SPECIFICATIONS - SILICA SAND REQUIREMENTS
DOMGLAS LTD. (Ref. 2.4)

	Flint Sand	Coloured Sand
Chemical		
SiO_2	Constant ± 0.25%	Constant ± 0.4%
Fe_2O_3	0.035% Max.	0.15% Max.
Al_2O_3	Constant ± 0.05%; 2.0% Max.	Constant ± 0.15%; 2.0% Max.
CaO	Constant ± 0.15%	Constant ± 0.15%
MgO	Constant ± 0.10%	Constant ± 0.10%
Na_2O	Constant ± 0.12%	Constant ± 0.02%
K_2O	Constant ± 0.03%	Constant ± 0.04%
TiO_2	0.05% Max.	0.10% Max.
Cr_2O_3	2 PPM	0.005% Max.
CO_3O_4	Nil	Nil
MnO	Nil	
L.O.I.	0.20% Max.	0.30% Max.
Cu.	Nil	Nil
Ni.	Nil	Nil
H_2O	0.10% Max.	0.10% Max.
Organics	0.01% Max.	0.10% Max.
Physical		
Screen		
20	Nil	Nil
30	0.5% Max.	0.5% Max.
40	-	5% Max.
-100	10.0% Max.	10.0% Max.
-200	3.0% Max.	3.0% Max.

TABLE 2.4

SPECIFICATION REQUIREMENTS FOR FOUNDRY SAND
(Ref. 2.5, 2.10)

Application	SiO_2 Min	Al_2O_3 Max	Fe_2O_3 Max	CaO Max	Grain Size
Molding and Core	92+				0.3-0.4 mm[1]
Refractory					
- Silica brick	95-99	0.1-2.8	0.3-1.3	0.2-2.4	0.1-0.2
- Fire brick	80-90				

[1] Subangular to rounded grains preferred

2.4 Silicon Carbide (Sand)

Silicon carbide is used as an abrasive, as a refractory, and as a deoxidant in the manufacture of iron and steel. The raw materials for silicon carbide production are high quality silica sand, carbon (usually petroleum coke), salt and sawdust; these being combined in an electric furnace at a very high, controlled temperature. The iron and aluminum contents of the silica sand are important--a typical specification being 99.5 percent (max) SiO_2, a maximum of 0.06-0.25 percent Al_2O_3, 0.1 percent Fe_2O_3, and no phosphorous. Table 2.5 gives general chemical and physical specifications for silicon carbide sands as required by two producers in Quebec (Electro Minerals Inc. of Shawinigan and Norton Company of Cap de Madeline).

TABLE 2.5

TYPICAL SPECIFICATION REQUIREMENTS
FOR SILICON CARBIDE SAND (Ref. 2.6 and 2.7)

Chemical

SiO_2	99.50% Min.
Al_2O_3	0.10% Max.
Fe_2O_3	0.10% Max.
CaO	0.05% Max.
MgO	0.05% Max.
Other impurities	0.10% Max.
Loss on ignition	0.05% Max.

Physical

U.S. Screen Size	% by Weight Passing
# 80	99-100
# 50	0-20
#100	0

2.5 Smelter Flux (Sand and Lump)

Unconsolidated sands and also massive quartz, quartzite and sandstone are used for flux in smelting base metal ores. Free silica content should be as high as possible but can be as low as 90 or even 80 percent SiO_2. Minor amounts of impurities such as iron (0.2 percent max. Fe_2O_3), alumina (0.4 percent max. Al_2O_3), calcium and magnesium ([CaO+MgO] max.) are tolerable. Brunswick Smelting at Belledune require 6 mm minus silica sand, 90 percent minimum SiO_2, with a maximum moisture content of 6 percent.

2.6 Sandblasting/Abrasives (Sand)

Silica sand for sandblasting purposes does not need to meet rigorous chemical specifications. Hardness and toughness are the prime requirements. Sand particles should be free of clay and other coatings which may cause clogging. Although angular sand grains promote better cutting action, this advantage is eliminated by an increase in the loss of fines; the sand invariably being recovered for reuse. Particle size distribution must be controlled: typical size limits being as shown in Table 2.6.

TABLE 2.6

GRADATION OF TYPICAL BLAST SAND GRADES
(Ref. 2.8)

Grade	Size Range Mesh #	mm
No. 1	20-35	0.8-0.5
2	10-28	2.0-0.6
3	6-10	3.4-2.0
4	4-8	4.8-2.4

Although silica is only moderately hard when compared with diamond, silicon carbide emery and garnet, it is often used as an abrasive in preference to these harder materials because of its low cost and widespread availability. Uniformity of gradation is crucial in fine polishing or grinding applications, since even one oversize particle may ruin the surface of a workpiece.

2.7 Chemical Uses (Sand)

Sodium silicate is produced by fusing 20 to 100 mesh high purity silica sand with sodium carbonate. It is used in soaps to impart hardness and durability, as a fixing agent in textile printing and as a cleaner.

Silicon tetrachloride is produced by the chlorination of silicon, ferrosilicon or silicon carbide. It is used as a modifying agent in plastics; as a drying oil in paints, and as an ingredient in silicone production. Silicone is used to make fabrics highly water repellent and stain resistant. It is also used in the manufacture of polishes, cosmetics, lubricants, adhesives, nonstick coatings, electrical insulation, caulking, etc.

Other chemical compounds derived from silica include activated silica which is used to aid coagulation in water treatment processes, and silica gel which is utilized as a desiccant.

Typical specification requirements for silica sand for the chemical industry are shown in Table 2.7.

TABLE 2.7

SILICA SAND SPECIFICATION REQUIREMENTS
CHEMICAL INDUSTRY (Ref. 2.10)

	SiO_2 Min.	Al_2O_3 Max.	Fe_2O_3 Max.	CaO + MgO Max.
Sodium Silicate	99	1.0	0.1	0.5
Silicon Tetrachloride	NA			
Activated Silica	NA			
Silica Gel	NA			

2.8 Hydraulic Fracturing (Sand)

Sand is used in the hydraulic fracturing of oil-bearing strata to increase open-pore spaces thus increasing the productivity of the oil well. Sand utilized for this purpose should be clean

and dry, have a high compressive strength, be free of acid-consuming constituents and have a grain size between 20 and 35 mesh. Grains should be well-rounded to facilitate placement in the formation in order to provide maximum permeability.

2.9 Silicon, Ferrosilicon (Lump)

High purity lump quartz, quartzite, silica gravel, and well cemented sandstones are used in the manufacture of silicon, ferrosilicon, silica manganese and other silicon alloys. Quartz suitable for silicon production is required to have more than 98 percent SiO_2, no phosphorous or arsenic, less than 0.2 percent each of lime and magnesia, and a very low alumina content. Table 2.8 gives some typical lump silica requirements for metallurgical applications.

TABLE 2.8

LUMP SILICA SPECIFICATION REQUIREMENTS
FOR METALLURGICAL APPLICATIONS (Ref. 2.9)

	SiO_2 Min.	Al_2O_3 Max.	Fe_2O_3 Max.	Ca&MgO Max.	P_2O_5 Max.
Silicon	99.5	0.2	0.3		
Ferrosilicon	98.5	0.4	0.5	0.2 each	0.1

Weak or friable sandstones cannot be used because technical melting requirements are such that a certain rock size must be maintained prior to the meltdown of a rock within a furnace. Since much contamination comes from the surface of the quartz particles, lumps of greater than 25 mm in diameter are preferred to reduce the surface area; 10 mm to 125 mm material is normally acceptable. Elchem reportedly require a slump size of 25 mm x 100 mm for one of their silicon metal plants in West Virginia.

In addition to SiO_2 requirements, the quartz should not decrepitate below 950°C and should have a minimum softening point of 1700°C. Requirements for quartz for ferrosilicon production are similar, if slightly less rigorous.

The production of one tonne of 75 percent FeSi requires 2 tonnes of quartz, 1.1 tonnes of coke and 0.25 tonnes of iron, and consumes 9000 to 11 000 kWh of energy. Energy consumption in silicon production is 50-60 percent higher than that for ferrosilicon.

2.10 Conclusions

Individual sources of lump silica and silica sand may meet the physical and chemical requirements of one or many consumer industries.

The variety and complexity of the different silica specifications discussed above has lead us to believe that, at least from the point of view of a market study such as this, some simplification would be appropriate. Accordingly, we have divided the silica market into two broad classes, as shown in Table 2.9. Class 1 silica is defined here as that sand or lump material meeting the more rigorous chemical requirements of the glass, metallurgical and chemical industries. Class 2 silica is lower value sand, specified for fluxing, foundry sand, sandblasting, etc. Ultimately, of course, a silica producer must have a product meeting individual consumer requirements. In many cases, this can be achieved by processing or otherwise beneficiating the raw material, albeit at extra cost.

TABLE 2.9

PROPOSED SILICA CLASSIFICATION
BY END-USE

	SAND	LUMP	
Class 1	Glass sands Silicon carbide	Sodium silicate Silicon Ferrosilicon	Decreasing specification requirement ↓
Class 2	Fluxing sand Foundry sand Sandblasting		

2.11 References

2.1 U.S. Bureau of Mines

2.2 Johnson, S.J., 1961. Minerals for the chemical and allied industries. John Wiley & Sons, New York

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2.4 Personal Communication; W.G. Lockhart

2.5 Industrial Minerals; May 1976, Silica: World production, consumption and trade

2.6 Communications with Electro Minerals Inc. and the Norton Company

2.7 Industrial Minerals; December 1980, Silicon Carbide - through hard times

2.8 Personal Communication; J. A. Leslie

2.9 Marleau, R.A., Geologie economique (Quartzite de La Galette), The Geology of Industrial Minerals in Canada

2.10 RPC, Report No. M/75/241, Sand Resources for the Moncton Area, 1975

3. SILICA IN NEW BRUNSWICK

3.1 History of Production

New Brunswick has no history of silica production prior to 1974. During 1974 and 1975 trial shipments of silica, for fluxing at the Belledune lead smelter, were made from the Ronalds Bass River Silica Deposit. Production commenced in 1976 at the rate of 15 000 tonnes per year. Current production is in the range of 50 000 tonnes per year. The primary market is smelting flux at the Belledune lead smelter. Secondary markets are blasting sand, nursery sand, and as a cement additive used by Canada Cement Lafarge at their Havelock, N.B. plant. The Bass River Silica Deposit is a Pennsylvanian age quartz sandstone.

In 1981 a major silica gravel and sand deposit, hereafter referred to as the Lockhart Silica Deposit, was discovered near Sussex, N.B. Between 1982 and 1985, this deposit was extensively explored and tested by Baskatong Quartz Inc. with encouraging results. Preliminary production is anticipated from the Lockhart Silica Deposit during 1986 or 1987, destined for Silicon Metal, Silicon Carbide and, eventually, glass markets.

3.2 Active and Potential Sources in New Brunswick

3.2.1 General

A total of 37 potential silica sources were sampled, studied and reported on in 1968 by J. B. Hamilton and J. K. Sutherland for the New Brunswick Department of Natural Resources (NBDNR), (Ref. 3.1). Most of these potential silica sources are impure, and few locally attain grades high enough to qualify them as significant silica occurrences. Nevertheless, Hamilton and Sutherland concluded that "the most promising raw materials are

the beneficiated quartzites because most of them contain more than 95 percent silica." Of these quartzites, they felt that the most promising were those of Precambrian age located on Ross, Nantucket and Whitehead--all small islands near Grand Manan. Of these, we have selected Whitehead Island for more detailed discussion.

Other silica-rich Precambrian quartzite locations noted by Hamilton and Sutherland include Delaney Lake, Burchill Road (Frenchman's Creek), Drury cove, Hunter's Cove, Frying Pan Lake and Green Head Peninsula. Of these, the largest reserves were believed to occur at Drury Cove; to be discussed further below. The Birchill Road deposit, evaluated by D. A. Williams and P. W. Kingston in 1977 for the NBDNR (Ref. 3.2) will also be examined in more detail here.

Cambrian through lower Carboniferous age rocks in New Brunswick contain no presently known silica occurrences with significant economic potential.

Upper Carboniferous (Pennsylvanian age Boss Point Formation) quartzitic sandstones from Coverdale (referred to hereafater as the Nixon/Calhoun deposit) near Moncton, and possibly from elsewhere within New Brunswick, appear to offer some promise if sufficient reserves could be proved. At Bass River, the Pennsylvanian age quartzitic sandstones are produced for smelter flux, blasting sand, nursery sand, and cement additive. However, it was found to be unsuitable chemically for coloured glass and is judged to be unsuitable chemically and physically for silicon metal and silicon carbide production. Both the Bass River and the Nixon/Calhoun deposits are discussed further below.

Quartz veins, intruded into upper Devonian-Mississippian volcanics in the West Beach and Cape Spencer area, were identified by earlier researchers and warrant further discussion here.

Surficial sands relatively rich in silica do occur within New Brunswick. To the date of the Hamilton/Sutherland report, 1968, none had been discovered which were chemically suited for glass manufacture. Fourteen beach sands from sites along the Northumberland Strait eastern coast of New Brunswick were tested. After beneficiation by both magnetic and acid methods, the best sands were found to contain 93% SiO_2, 3% Al_2O_3, 0.07% Fe_2O_3, 0.03% Mn, 0.019% TiO_2, and 3% combined CaO, Na_2O, K_2O. This is not a sufficiently pure silica sand to use for the high-value glass, metal and carbide silicon markets. Few, if any, of these beach sand deposits could be worked under existing legislation which prevents extraction of material from coastal beaches.

The recently discovered unconsolidated gravel and sand deposit at Sussex, N. B. (the Lockhart deposit) appears to have major potential as a silica source. It will also be examined in the section which follows.

3.2.2 The Ronalds Bass River Silica Deposit

This silica deposit is owned by Archie Ronalds and Gordon Ronalds. Their agent, A.W. Lockhart, negotiated an agreement in 1976 with Godin Mining and Exploration Limited, under which the deposit is operated. The product is sold through a sister company of Godin Mining and Exploration Limited, Chaleur Silica Ltd. This has been New Brunswick's only producing silica property to this date. The Bass River deposit commenced production in 1976 and has produced 300 000 tonnes of silica through 1985.

The silica is produced from a flat-lying, quartzitic sandstone of Pennsylvanian age that varies from 1 to 3 m thick. The adjacent Bass River has eroded overlying less siliceous beds and overburden to leave a very light grey, fine to coarse-grained, flaggy to massive and cross-bedded sandstone. The sandstone

consists almost entirely of clear and milky quartz grains, loosely packed and poorly cemented. This crumbly, porous rock appears to have had most of its matrix material removed by post-diagenetic action. Iron and manganese oxides deposited on the quartz grains by circulating ground water are common. Grab sample assays of 94.88% SiO_2 and 1.72% Fe appear to be representative of this deposit. Previous estimates of reserves have been based on outcrop observation, three very preliminary "pack-sack" drill holes (total 76 feet), and minor backhoe excavation of pits. A.B. Baldwin (February 16, 1961) concluded "very preliminary work suggests a tonnage potential of two million (tons) for that part of the band lying between Bass River and the western boundary of the property." Hamilton and Sutherland (1968) reported "An estimated 300,000 tons of sandstone averaging 98% SiO_2 are present in the Bass River area, but further drilling is needed to prove these reserves." In his 1976 report (Ref. 3.3) P.W. Kingston estimated "over 600,000 tons in place. It must be emphasized that this calculation is highly speculative in nature and is based on assumed continuity and attitude of the high silica unit."

The property has produced and sold 300 000 tonnes of silica to the end of 1985. This writer estimates that an equal or greater amount remains to be recovered from the Ronalds Bass River Silica Deposit. The current annual rate of mining is 50 000 tonnes. With continuous production at this rate, the deposit on the Ronalds farm is estimated to be exhausted by 1992. Thicker than average sandstone beds or a lower production rate could extend production to 1995 or later.

3.2.3 The Lockhart Silica Deposit, Sussex

The Lockhart Silica Deposit is located 15 km south of Sussex and 5 km northeast of the Denison-Potacan Potash Mine at Cassidy Lake. The deposit was discovered and partially explored by A.W.

Lockhart in 1981. An agreement was made in 1982 with Baskatong Quartz Inc. of Montreal whereby Baskatong Quartz Inc. could earn a 75 percent equity interest in the property by exploring, developing, and putting the property into production.

The deposit is an unconsolidated silica gravel and sand. The surface area is not less than 70 ha. A drilling programme consisting of 20 drill holes proved silica sand and gravel reserves to be a minimum of 18 million tonnes of recoverable aggregate. The origin and age of this deposit are not yet known.

Four years of exploration and development have proven, through beneficiation tests, pilot plant tests, and trial shipments of both hundreds and thousands of tonnes of product to potential customers, that the Sussex silica project can supply a wide variety of silica products. These products range from very coarse material (150 mm) to very fine material (100 mesh). Table 3.1 gives the results of some typical chemical analyses of sand and gravel samples recovered from the Lockhart deposit.

Specific products to be produced initially are:

1. Lump Silica for silicon metal production
2. Silica Sand for a) flint glass
   b) coloured glass
   c) silicon carbide
   d) fiberglass insulation
   e) sandblasting
   f) miscellaneous use.

Initial capacity of the Sussex silica project is estimated to be 80 000 tonnes per year of sand and pebbles. Expansion to 180 000 tonnes per year could be accomplished when market demand justifies expansion. Start-up may be as early as June 1986.

TABLE 3.1

CHEMICAL ANALYSES - SAND AND GRAVEL FROM LOCKHART DEPOSIT

	SiO_2	Al_2O_3	Fe_2O_3	TiO_2	Cr_2O_3	ZnO_2	CaO	MgO	Na_2O	K_2O	LOI	Total
Washed pit run sand (0.42-3.4 mm)	99.18	0.34	0.10	0.032	0.003	0.012	0.06	0.03	0.01	0.04	0.22	100.03
Washed pebbles	1984	0.099	0.025	0.011	-		0.007	-	-	-	-	-
	1985	0.160	0.014	0.012	-		0.007	-	-	-	-	-

3.2.4 West Beach - Cape Spencer

Hamilton and Sutherland (Ref. 3.1) noted that "numerous quartz veins transect the Lower Carboniferous formations in the Mispec-Black River area of Saint John County." Although they concluded that vein quartz in New Brunswick would probably not be an economic source of silica, there has been subsequent interest in deposits at West Beach and Cape Spencer. Mining claims held by Mr. W. Walton (Cape Spencer) and Mr. M. Gordon of Pennfield Metallics Limited (West Beach) were optioned by Ahlstrom Canada Limited (Ref. 3.2), for potential utilization as glass sand.

The West Beach silica vein is believed to be 30 feet wide and some 1400 feet long, on which basis reserves of 200 000 tons have been calculated (Ref. 3.4). At Cape Spencer (Millican Brook) another quartz vein vein outcrops over a 280 feet by 900 feet area; estimated potential between 400 000 tons (Ref. 3.4) It is believed that a larger quartz vein of similar character exists to the east of the Millican Brook vein. Table 3.2 gives results of some typical chemical analyses carried out on vein quartz from these sources.

TABLE 3.2

RESULTS OF TYPICAL CHEMICAL ANALYSES
WEST BEACH - CAPE SPENCER QUARTZ VEIN DEPOSITS

Sample	SiO_2	Al_2O_3	Fe_2O_3	CaO	MgO	Na_2O	K_2O	TiO_2	MnO_2
West Beach[a]	99.57	0.024	0.014	0.01	0.01	0.03	0.21	0.02	ND
Cape Spencer[b]	-	0.07	0.07	0.01	0.00	0.03	0.02	0.00	-

[a] average of 5 analyses (Ref. 3.4)

[b] average of 4 samples (Ref. 3.2)

3.2.5 Burchill Road

The Burchill Road silica deposit consists of Precambrian quartzite outcropping in a belt approximately three miles long and 0.5 miles wide and extending northeast from Musquash Harbour. Hamilton (Ref. 3.5) estimated accessible reserves of ten million tons. Before beneficiation, analyses averaged 91.38 percent SiO_2, 3.18 percent Al_2O_3 and 0.97 percent Fe_2O_3. Following acid washing and magnetic separation, samples contained 96.30 percent SiO_2, 1.87 percent Al_2O_3 and 0.31 percent Fe_2O_3, still evidently too impure for higher end uses such as silicon metal, silicon carbide or glass production, but suitable for blast sand, foundry sand and for construction purposes.

Williams and Kingston (Ref. 3.2) envisaged development of this deposit as both an aggregate and silica source, and suggested a minimum production capacity of 50 000 and 10 000 tons per year for each use respectively. They point out that "development of the deposit is subject to agreement with the owner of surface rights (New Brunswick Development Corporation) and arrangements with the City of Saint John and the Province of New Brunswick." The current status of the land use conflict between the City of Saint John and NB Power is unknown.

3.2.6 Whitehead Island

As noted in Section 3.2.1, fairly pure quartzites occur on several small islands southeast of Grand Manan Island. Of these islands, the Whitehead Island deposit perhaps has the greatest potential as a silica source. Potential reserves of 850 000 tons have been estimated (Ref. 3.2) assuming that no quarrying is to be conducted below high tide level. Results of chemical analyses are given in Table 3.3.

TABLE 3.3

RESULTS OF TYPICAL CHEMICAL ANALYSES
WHITEHEAD ISLAND QUARTZITE

SiO_2	Al_2O_3	Fe_2O_3	CaO	Na_2O	K_2O	TiO_2	MnO	Total
98.22[a]	0.67	0.20	-	-	-	-	-	-
98.14[b]	0.73	ND	0.07	0.02	0.11	0.08	~0.01	99.16
98.99[b]	0.64	0.07	0.10	0.03	0.11	0.04	~0.01	99.99
98.90[b]	0.80	0.17	0.09	0.03	0.16	0.03	0.01	100.09

[a] Ref. 3.2, p. 46
[b] Ref. 3.1, Table 6

3.2.7 Drury cove

Precambrian high-silica quartzite occurs on the west side of Drury Cove in Saint John, N. B. A composite sample representing approximately 50 feet of strata exposed along the (Kennebecasis) shore gave the following results (Table 3.4).

TABLE 3.4

ANALYTICAL RESULTS
QUARTZITE SAMPLE FROM DRURY COVE, N. B. (REF. 3.1)

SiO_2	Al_2O_3	Fe_2O_3	CaO	Na_2O	K_2O	TiO_2	MnO	Total
95.23	2.39	0.60	0.25	0.34	0.68	0.06	0.02	99.57

Estimated silica reserves at Drury Cove are 650 000 tons (Ref. 3.1).

3.2.8 Nixon/Calhoun

Quartzose sandstones belonging to the Boss Point Formation occur in a 20 mile long band extending northeast from Nixon to Calhoun, southeast of Moncton. The sandstones are similar to those now under production at Bass River (see 3.2.2).

Webb (Ref. 5) noted that "the high quality silica bearing units are not nearly as widespread as previously thought. In fact, they may be only of local significance, existing as separate channel deposits ..." The iron and alumina concentrations of nonbeneficiated sandstone samples from the Nixon/Calhoun area are relatively high. Webb reports average values of 0.93 percent Fe_2O_3 and 2.13 percent Al_2O_3. Even though acid beneficiation would appreciably reduce these concentrations, Webb concluded that "the thin, lenslike nature of the deposits and the presence, in most cases, of thick sequences of overlying rock units probably will never make exploiting these deposits a profitable undertaking."

Table 3.5 gives the results of chemical analyses on quartzose sandstones from Nixon, Lower Coverdale and Fox Creek.

TABLE 3.5

ANALYTICAL RESULTS
QUARTZOSE SANDSTONE
BASS POINT FORMATION (REF. 3.1)

Location	SiO_2	Al_2O_3	Fe_2O_3	CaO	Na_2O	K_2O	TiO_2	MnO	Total
Nixon	98.86	2.54	0.22	0.10	0.02	0.12	0.11	0.01	99.98
Lower Coverdale	97.75	0.99	0.45	0.12	0.01	0.10	0.37	0.01	99.80
Fox Creek	98.36	0.85	0.21	0.10	0.07	0.11	0.18	0.05	99.93

3.3 References - Silica in New Brunswick

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1968: Silica in New Brunswick; New Brunswick Department of Natural Resources, Report of Investigation No. 2

3.2 Williams, D. A. and Kingston, P. W.
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4. SILICA IN NOVA SCOTIA

4.1 History of Production

Table 4.1 gives the total silica production in Nova Scotia from 1960 to 1984. Prior to this period, production from quartzites at Chegoggin Point near Yarmouth and from sands at Diogenes Brook near Melford, Cape Breton Island, is reported to have been 72 356 and 13 000 tonnes, respectively. At Chegoggin Point, Silurian quartzite was quarried from 1945 to 1960. Interest in this deposit has recently been revived; the objective being to determine the feasibility of supplying the silicon alloy industry in the eastern United States and Quebec.

Although detailed production data have not been compiled for silica production from Cape Breton Precambrian quartzites, it is thought to be substantailly over 200,000 tons. At Leitches Creek, for example, quartzite of the Precambrian George River Group was quarried for use in the Sydney steel plant.

The current average production rate at the only Nova Scotian source of silica sand in active operation at the time of writing--Nova Scotia Sand and Gravel Company's deposit at West Indian Road (Shubenacadie) is approximately 75 000 tonnes per annum. In the period 1980 to 1984, annual production varied from a low of 15 000 tonnes in1983 to 132 269 tonnes in 1981. Last year's production (1984) was reportedly 110 000 tonnes.

TABLE 4.1

NOVA SCOTIA SILICA PRODUCTION: 1960-1984

Location	Source	Production (tonnes)	1984 Status
Belmont	sand	82 652	Idle
Sandy Desert	esker	18 259	Idle
West Indian Road	sand	357 836	Producing
Elderbank	vein	4 772	Idle
Elmsvale	sand	90 201	Some exploration
Rawdon	vein	831	Idle
Chegoggin Point	quartzite	7 562	Some exploration

4.2 Active and Potential Silica Sources

4.2.1 General

Quartz-rich rock or quartzite occurs in several geologic environments in Nova Scotia. Many of these have been investigated in the past as potential sources for moulding sand and for the manufacture of silica bricks. Quartzite of the Precambrian George River Group has been quarried at Leitches Creek on Cape Breton Island. Other areas of similar material occur on Cape Breton Island at George River, Skye Mountain, Aberdeen, Bucklaw and Iron Mines.

Silurian quartzites occur at Chegoggin Point near Yarmouth and at White Rock in Kings County.

During the 1960s, the Nova Scotia Department of Mines and Energy investigated sandstone of the Mississippian Horton Group near Hantsport, Kings County, to determine if it was suitable for the production of silica. It was concluded that the most promising sandstone unit was too thin and the overburden depth too great to make open pit extraction viable.

Development of quartz veins in Meguma terrain at Elderbank and Rawdon has been undertaken in the past. Production was, however, limited, and total reserves are believed to be relatively small.

Unconsolidated silica sand deposits having the most potential are those of Cretaceous age. They occur overlying Mississippian Windsor Group rocks near contacts with Pre-Carboniferous basement rock. Fault structures and differential weathering along these contacts are thought responsible for the development of Cretaceous sedimentary basins of sufficient depths to be protected from subsequent glaciation. Beds consisting of almost pure angular quartz grains occur in sedimentary sequences which include clay and lignite horizons. These sequences and their thicknesses are reported to vary greatly over short distances. In some localities, these deposits are buried under considerable thicknesses of glacial drift. The better known deposits occur at Elmsvale in the Musquodoboit structural basin and at West Indian Road (Brazil Lake) in the Shubenacadie structural basin. Other, smaller, lesser known deposits are reported in the Shubenacadie basin and at Pembroke, Colchester County.

Some silica sand was produced from a deposit at Belmont, west of Truro, between 1960 and 1966. Very limited production from this deposit took place in 1984 and 1985 by Canada Cement Lafarge; this being 500 tonnes or so in 1985. The sand was utilized as a specialty fire aggregate for grouts supplied to the offshore drilling market. This deposit, of unknown age, comprising rounded sand grains, is reported to form a "pocket" in red clays.

Beach sands, of Holocene age, have been investigated at Port Mouton and Barrington on the province's south shore. These, however, are now restricted beaches from which extraction is prohibited.

The best potential for the discovery of additional Cretaceous sediments is thought to be in the Shubenacadie and Musquodoboit Basins. Detailed studies concerning structure, stratigraphy and sedimentary processes could lead to the discovery of new deposits or extensions to known deposits. Such studies could also result in the delineation of potential areas in other sedimentary basins. However, in either case, the depth of burial and thickness of glacial cover may be detrimental to both their discovery and extraction.

From the geographical viewpoint, we have identified four promising silica deposits (or areas within which suitable silica sources may be located) warranting further discussion. Cape Breton "West" and "East" are distinguished from each other, not on geological grounds, but in recognition that bulk silica exported from these sources would probably be handled by different ports; Port Hawkesbury to the west and Sydney in the east.

4.2.2 Shubenacadie

Nova Scotia Sand and Gravel produce silica sand at their West Indian Road Deposit near Shubenacadie. Unconsolidated Cretceous sands are mined in conjunction with overlying clays; both materials being utilizd for brick production. The silica deposit is relatively pure, rendering it suitable for higher value uses. Table 4.2 gives the results of a chemical analysis carried out on a bulk sample from the West Indian Road deposit.

TABLE 4.2

RESULTS OF CHEMICAL ANALYSIS
WEST INDIAN ROAD DEPOSIT

Silica	99.10%
Alumina	0.38%
Iron Oxide	0.14%
Lime	0.00%
Magnesia	0.00%
Soda	0.00%
Potash	0.02%
L.O.I. @ 1200°C	0.32%

Reserves of Cretaceous sands in the Shubenacadie and Musquodoboit basins is estimated to be in excess of one million tonnes.

4.2.3 Chegoggin

At Chegoggin Point, near Yarmouth, quartzite of the White Rock formation of Silurian age was quarried from 1945 to 1960. Diamond drilling by the Nova Scotia Department of Mines in the 1960s traced the favourable horizon some 18 km northeast to Lake George. Table 4.3 gives the results of a typical chemical analysis of the Chegoggin quartzite.

TABLE 4.3

RESULTS OF CHEMICAL ANALYSES
CHEGOGGIN AND WHITE ROCK QUARTZITES

Location	SiO_2	Al_2O_3	Fe_2O_3	CaO	MgO	MnO
Chegoggin	97.10	0.97	0.51	0.28	0.10	-
White Rock	92.62	1.75	2.30	0.90	0.70	0.03

By way of comparison, quartzite belonging to the same geological formation occurring at White Rock in Kings County appears to be significantly less pure.

Reserves at Chegoggin are unknown but believed to be very large. Exploration is planned in this area by private interests. The objective is to ascertain whether or not the resource is of the type and quantity necessary to become a supplier to the silicon alloy industry.

4.2.4 Cape Breton "East"

Several locations of silica-rich Precambrian quartzite occur on the eastern side of Cape Breton within reasonable trucking distance of Sydney. These include deposits at Leitches Creek and George River. The results of typical chemical analyses on these quartzites are shown in Table 4.4. Reserves are unknown.

TABLE 4.4

RESULTS OF CHEMICAL ANALYSES
SILICA SOURCES IN CAPE BRETON EAST (REF. 4.9)

Location	SiO_2	Al_2O_3	Fe_2O_3	CaO	MgO
Leitches Creek	93.30	1.45	0.19	-	-
George River	96.91	0.66	1.38	0.12	0.27

4.2.5 Cape Breton "West"

Similar quartzites to those identified at Leitches Creek and George River occur further west. Reserves are unknown.

In addition to the quartzites, silica sand, possibly of Cretaceous age, occurs along the stream valley of Diogenes Brook, near Melford, Cape Breton Island. Sand and clay occur beneath considerable thicknesses of glacial drift. Clay is present in varied quantities both in the sand and as distinct horizons. Estimated reserves are 110 000 to 130 000 tonnes.

The results of typical chemical analyses on the quartzites and sands are given in Table 4.5.

TABLE 4.5

RESULTS OF CHEMICAL ANALYSES
SILICA SOURCES IN CAPE BRETON WEST (Ref. 4.9)

Location	SiO_2	Al_2O_3	Fe_2O_3	CaO	MgO
Skye Mountain	97.37	1.34	0.48	0.12	0.11
Aberdeen	96.09	2.15	0.49	0.10	0.36
Bucklaw	88-90	5.57-8.80	0.80-3.30	low	low
Iron Mines	97.66	1.39	0.40	0.20	0.10
Diognes Brook	98.80	0.87	0.05	-	-

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5. POTENTIAL MARKETS

5.1 World

In spite of the abundance and relatively low cost of the materials, the uneven distribution of good quality commercial deposits of silica and silica sand in the world has given rise to significant trade. The trade is generally confined to countries within a single continent and generally only involves the highest value silica and silica sands. In North America, for example, Canada annually imports approximately one million tonnes of high quality silica sand from the United States, while quartzite is exported to the United States, albeit in small quantities.

In Europe the main sources of silica sands are Belgium, France, West Germany and the Netherlands. Exports go almost exclusively to European neighbours such as the U.K., Italy and Switzerland. A limited quantity of silica sand is exported to North America from Europe, and such exports might increase if European companies acquire U.S. producing companies with established markets. Such purchases have been made. In 1980, for example, Hepworth Ceramic Holdings, the parent company of British Industrial Sand, bought the two silica sand operations of Manley Brothers of Indiana (estimated capacity 2 million tons per annum destined for foundry, glass and frac sand markets). Sibelco (Belgium) is reportedly linked to Unimin (see Table 5.2).

Lump quartz production in Europe, destined for silicon metal and ferrosilicon production, is concentrated in the south, particularly in Italy, Yugoslavia, Spain and Portugal. The rest of Europe, including the major silica sand producers, France excepted, depend almost entirely on imports.

TABLE 5.1

LIST OF WORLD SILICA PRODUCERS

	Quartz	Quartzite	Silica Sand
ARGENTINA			
Ingemar Srl	x		
Piedra Grande SA	x		
La Ceramica del Plata SA		x	
Cristamine SA			x
AUSTRALIA			
Lennard Oil No. Liability	x		
David Mitchell Estate Ltd.		x	
Newbold Raw Matrials, Div. of Newbold General Refractories Ltd.		x	x
Minerals Resources Div., Australian Consolidated Industries Ltd.			x
Cape Flattery Silica Mines Pty. Ltd.			x
Hooker Industrial Sands			x
AUSTRIA			
Industrie- und Bergbaugesellschaft Pryssok & Co. KG	x	x	x
BELGIUM			
Ets. J. Delbar-Bex SA			x
ECTP-Stê. d'Exploitation de Carrières de Terres Plastiques SA			x
Les Nouvelles Sablières de Mol SA			x
SA SCR-Sibelco NV			x
SA S.Pasek & Cie.			x
BRAZIL			
MIBRACO-Mineracao Brasileira Commercial Ltda.	x		
Magnesita SA		x	x
Mineracao Jundú SA		x	x

TABLE 5.1 (continued)

LIST OF WORLD SILICA PRODUCERS

	Quartz	Quartzite	Silica Sand
BURMA			
Mining Corp. (IV) (formerly Industrial Minerals Corp.)		x	
CANADA			
Indusmin Ltd.		x	x
Mountain Minerals Ltd. (development stage)		x	
Union Carbide Canada Ltd.		x	
S.I.L. Silica Ltd.			
CZECHOSLOVAKIA			
Czechoslovak Ceramics	x	x	
EGYPT			
Nasr Phosphate Co.	x		
FINLAND			
Oy Lohja Ab	x	x	x
Paraisten Kalkki Oy-Pargas Kalk Ab	x		
FRANCE			
Kaolins & Pates Céramiques du Limousin	x		
SIKA SA-Produits Minéraux Siliceux du Sud-Est	x		x
Ets. Louis Perazio SA			x
Sifraco Sarl (see SA SCR-Sibelco NV, Belgium)			x
WEST GERMANY			
Adendorer Tonbergbau Erhard Fischer KG	x		
Amberger Kaolinwerke GmbH	x		x
Dorentruper Sand- und Thonwerke GmbH	x	x	
Gebruder Dorfner OHG, Kaolin- und Kristallquarzsandwerke	x		x
Hurtherberg Steine und Erden GmbH	x		x

TABLE 5.1 (continued)

LIST OF WORLD SILICA PRODUCERS

	Quartz	Quartzite	Silica Sand
WEST GERMANY (continued)			
Eduard Kick, Kaolin- und Quarzsandwerke	x		
Walter Rysse KG, Sandgruben-Fuhrbetrieb	x	x	
Tonwerke Schmitz GmbH	x		x
Westdeutsche Quarzwerke Dr. Muller GmbH	x		x
Peter Bartz Quarzite KG		x	
Didier-Werke AG		x	
Martin & Pagenstecher GmbH		x	
Didier-Werke AG			x
Dorentruper Sand- und Thonwerke GmbH			x
EKW Eisenberger Klebsand-Werke GmbH			x
Franz Hoffman & Sohne, Chem. Fabrik			x
Keramische Rohstoffwerke Bauscher-Mandt GmbH			x
Quarzwerke GmbH			x
GREECE			
Project Studies and Mining Development Corp. SA	x		
Filis Evangelos			x
General Enterprises Sarides SA			x
Titan Cement Co., Dept. of Milos Minerals			x
HONG KONG			
Hongkong Mining & Trading Co.	x		
Kowloon Kaolin Co. Ltd.			x
HUNGARY			
Mineralimpex			x
INDIA			
Bharat Mineral Supply Corp.	x		
Golecha Palawat & Co.	x	x	
Horgovindas Shivlal & Co.	x		x
Harihareswara Mineral Traders	x		x

TABLE 5.1 (continued)

LIST OF WORLD SILICA PRODUCERS

	Quartz	Quartzite	Silica Sand
INDIA (continued)			
Mineral Dressing & Pulverising Co.	x		x
S. Prabhakarrao & Co.	x		
Gujarat Mineral Development Corp. Ltd.			x
Kanahiyalal Ghatiwala			x
Modiram Ramlal			x
Nanak Singh Sardari Lal			x
Oriental Minerals			x
Rai Bharat Das & Bros.			x
The Rajasthan Mineral Traders			x
INDONESIA			
Pengusaha Pasir Gelas 'M. Ali Sulfagar M. Tamé			x
P.T. Baksmintraco Ltd.	x		x
Usaha Pasir Kwarsa Bangka			x
IRAN			
Foundry Sand Co.			x
IRAQ			
National Iraqi Minerals Co.			x
ISRAEL			
Negev Ceramic Materials Ltd.	x		
ITALY			
Accornero Luigi & Figlio			x
Intermat Sas.			x
Italmineraria SpA			x
Cave Silice Revello Sas	x	x	x
Follonica Cave e Miniere sri	x	x	x
IMED SpA	x	x	x
C. Maffei & C. Monte Orno SpA	x		
Rosboch-Cave Erl	x	x	x

TABLE 5.1 (continued)

LIST OF WORLD SILICA PRODUCERS

	Quartz	Quartzite	Silica Sand
ITALY (continued)			
Sels	x	x	x
Socalpi Srl	x	x	x
La Quarzite Stà. per Azioni		x	
Stà. Mineraria Baritina SpA		x	
Siro SpA		x	x
Sanac SpA, Refrattari Argille e Caolini			x
JORDAN			
The Public Mining Co. Ltd.			x
NETHERLANDS			
Lieben, Exploitatie- en Handelsonderneming BV	x		x
MEXICO			
Materias Primas Monterrey SA			
NEW ZEALAND			
New Zealand China Clays Ltd.	x		
McSkimming Industries Ltd.			x
Winstone Ltd.			x
NORTH KOREA			
Korea Paekgumsan Trading Corp.		x	
NORWAY			
H. Bjorum	x	x	
K/S Norfloat A/S & Co. (see H. Bjorum)	x		
A/S Norsk Feldspat Co.	x		
PAKISTAN			
Mushtaq Sons			x
PERU			
Cia. Minera Agregados Calcareos SA	x	x	x

TABLE 5.1 (continued)

LIST OF WORLD SILICA PRODUCERS

	Quartz	Quartzite	Silica Sand
PHILIPPINES			
Bellamar Mining Association			x
Canuto Agbing			x
Farmont Mines Co. Inc.	x		x
Republic Glass Corp.			x
PORTUGAL			
A.J. da Fonseca Lda.	x	x	
Cia. Portuguesa de Fornos Electricos Sarl	x		
Quartzograno-Sociedade de Granulacao de Quartzo Lda.	x		
Minas de Barqueiros Lda.			x
RUMANIA			
Impexmin	x		
SOUTH AFRICA			
Ceramic Minerals (Pty.) Ltd.	x		
Otavi Mining Co. (Pty.) Ltd.	x		
Rand London Corp. Ltd.	x		
Marico Mineral Co. (Pty.) Ltd.		x	
Elgin Refractories Ltd.			x
Industrial Sand & Engineering Co. Ltd.			x
S.A. Manganese Amcor Ltd. (Samancor)			x
Silicon Smelters (Pty.) Ltd.			x
SPAIN			
Lorda y Roig SA	x		
SWEDEN			
Ahlsell & Agren AB Div. Industrial Raw Minerals	x		x
AB Forshammars Bergverk	x	x	

TABLE 5.1 (continued)

LIST OF WORLD SILICA PRODUCERS

	Quartz	Quartzite	Silica Sand
TURKEY			
Eczacibasi Seramik Fab. A.S.	x		x
Sevket Ali Gozlulu, Fire Resisting Minerals	x	x	x
Kale Madencilik		x	
Turk Ytong Sanayi A.S.		x	
Yalikoy Kuarsit Isletmesi		x	
UNITED KINGDOM			
Amey Roadstone Corp. Ltd.		x	
The Blue Circle Group		x	x
Kingston Minerals Ltd.		x	
Mixconcrete Aggregates Ltd.		x	x
British Industrial Sand Ltd.			x
Buckland Sand & Silica Co. Ltd.			x
DSF Refractories			x
George Garside (Sand) Ltd.			x
Harrison's Limeworks Ltd.			x
Siminco Ltd.			x
Tilling Construction Services Ltd.			x
UNITED STATES			
Harris Mining Co., Div. Blue Diamond Coal Co.	x		
IMC Chemical Group Inc., Industrial Minerals Div.	x		
Pacer Corp.	x		
Pennsylvania Glass Sand Corp.	x		
San Antonio Mica Mine	x		
General Refractories Co.		x	
Industrial Mineral Products Inc.		x	x
Edgar Plastic Kaolin Co., Div. of NL Clays Corp.			x
General Refractories Co.			x
Great Lakes Minerals Co.			x
Illinois Minerals Co.			x

TABLE 5.1 (continued)

LIST OF WORLD SILICA PRODUCERS

	Quartz	Quartzite	Silica Sand
UNITED STATES (continued)			
IMC Chemical Group Inc., Industrial Minerals Div.			x
Kings Mountain Mica Co. Inc.			x
Martin Marietta Corp.			x
NL Clays Corp.			x
Oglebay Norton Co.			x
Pennsylvania Glass Sand Corp.			x
South River Sand Co.			x
USSR			
V/O Techsnabexport			x
YUGOSLAVIA			
Factory Partizan	x		
Rudnici za Talk 'Dimce Mirceŭ	x		
Rudnici 'Bentomak', Kriva Palanka		x	
ZIMBABWE			
Lomagundi Mining Pvt. Ltd.	x		

TABLE 5.2

TOP 25 PRODUCERS OF INDUSTRIAL SAND AND GRAVEL
IN THE USA IN 1982

Company	No. of Operations	States
Pennsylvania Glass Sand Corp.	12	Missouri, New Jersey, Ohio, Okalhoma, Pennsylvania, S. Carolina, Texas, Virginia
Martin Marietta Corp. (10 plants bought by Unimin in 1983)	11	California, Idaho, Illinois, Indiana, Iowa, Michigan, Missouri, S. Carolina, Texas, Wisconsin
Unimin Corp. (10 additional plants bought from Martin Marietta 1983)	5	Illinois, Minnesota, Missouri, New Jersey, Virginia
Ottawa Silica Co.	6	California, Connecticut, Illinois, Louisiana, Michigan, Texas
Jesse S. Morie & Son Inc.	7	Alabama, Georgia, New Jersey, Tennessee
Oglebay Norton Co.	4	Ohio, Texas
Owens-Illinois	3	California, Illinois
Manley Brothers of Indiana Inc.	2	Illinois, Michigan
Sargent Sand Co.	4	Michigan
Alabama Silica Co. Inc.	2	Alabama
Badger Mining Corp.	3	Wisconsin
Reynold Electric & Engineering Co.	1	Nevada
Gifford-Hill & Co. Inc.	3	Arkansas, California
Nugent Sand Co. Inc.	2	Michigan
Simplot Industries Inc.	1	Nevada
Whitehead Brothers Inc.	6	New Jersey, Massachusetts, New York, S. Carolina
Lone Star Industries Inc.	5	California, Texas

TABLE 5.2 (continued)

TOP 25 PRODUCERS OF INDUSTRIAL SAND AND GRAVEL
IN THE USA IN 1982

Company	No. of Operations	States
Sand Products Corp.	2	Michigan
Silica Products Co.	1	Arkansas
Mid Continent Glass Sand Co.	1	Oklahoma
Walter C. Best Inc.	1	Ohio
Hub Materials Inc.	1	Kansas
Feldspar Corp.	3	Connecticut, Florida, North Carolina
State S & G Inc.	3	Louisiana
Specialty Sand Co.	2	Texas

Source: U.S. Bureau of Mines

Note: Unimin is now in second position after the acquisition of 10 Martin Marietta plants.

Table 5.1 shows those countries producing quartz, quartzite and silica sand in significant quantities in 1977. The depth of European production can be judged from this table, as can the general world proliferation of silica producers. A notable absentee from Table 5.1 is Japan, which imports silica sand from Australia (600 000 tons in 1974) and lump silica from South Korea (300 000 tons in 1974).

5.2 United States

The North American silica sand industry is highly competitive on a regional basis and producers tend to be secretive about production capabilities, grades and (especially) prices. Since transportation costs are such an important component of the delivered price of silica sand, there are many relatively small operations that supply local markets. Although there have been few new entrants into the silica sand industry in recent years, there have been several changes within the structure of the industry due to mergers and acquisitions. As a result, the previously discussed Table 5.1 is quite outdated, at least in regard to U.S. producers. Table 5.2 gives the top twenty-five producers of industrial sand and gravel in the U.S.A. in 1982. Unimin purchased ten out of the eleven silica sand operations owned by Martin Marietta Corp. and is now reported to be second only to Pennsylvania Glass Sand (PGS) in output.

As one of the world's largest producers and consumers of silica, the United States represents a very attractive market, especially for producers in the Maritimes. Many American markets are more accessible than comparable Canadian markets (Boston, New York versus Toronto, for example). They are also larger: the New England and mid-Atlantic American market* is almost twice as large as the total Canadian market.

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*New England and mid-Atlantic market includes Maine, New Hampshire, Vermont, Massachusetts, Rhode Island, Connecticut, New York, New Jersey and Pennsylvania.

To be successful in the American market, a supplier must sell quality silica in quantity, at a fair price, and be prepared to compete for market share. This section deals with the quantity the supplier must sell. Other sections deal with the quality (Section 2.0), fair price (Section 6.0 and 7.0) and competition (Section 8.0), the supplier must meet to succeed in the American market.

Presented in Tables 5.3 and 5.4 are the end uses for silica produced in the North East and South United States markets. Similar detailed information is not available on a state-by-state basis. However, through a literature search a series of rough estimates of end use were determined on a state-by-state basis (see Table 5.5)

Observations:

1. The Southern market is 150-180 percent larger than the Northeastern market.

2. The three top silica uses are the same for both markets.

3. As a preliminary screen, it is assumed that a New Brunswick or Nova Scotia producer may capture up to 10 percent of a market without encountering large scale reaction by competitors (price cuts, political pressure, "buy America"). Furthermore, as shown in Section 7.0, transportation must be by ship to be economic, and the smallest unit of ship transport is 7000 tonnes as part of a total shipload of 35 000 tonnes. Thus, a New Brunswick or Nova Scotia producer must aim for uses which consume over 70 000 tonnes/a. (This is a preliminary assessment which could be altered by price or quality considerations.)

TABLE 5.3

MAJOR USES OF SILICA PRODUCED IN
THE NORTHEASTERN UNITED STATES (1979-1983)
(U.S. BUREAU OF MINES MINERALS YEARBOOK)

Use	1980		1981		1982		1983	
	Thousand tonnes/a	%	Thousand tonnes/a	%	Thousand tonnes/a	%	Thousand tonnes/a	%
Sand:								
Glassmaking:								
Containers	1947	53.2	1486	47.1	1789	58.2	1072	34.5
Flat	80	2.2	W	-	W	-	W	-
Specialty	131	3.6	W	-	W	-	W	-
Fibreglass (UG)	66	1.8	W	-	W	-	W	-
Fibreglass (G)	75	2.0	W	-	W	-	W	-
Foundry:								
Molding and core	597	16.3	666	21.1	411	13.4	505	16.3
Facing	61	1.7	W	-	W	-	W	-
Refractory	41	1.1	65	2.1	W	-	W	-
Metallurgical:								
Silicon carbide	1	-	W	-	W	-	W	-
Flux	-	-	-	-	-	-	-	-
Abrasives:								
Blasting	129	3.5	104	3.3	131	4.3	173	5.6
Scouring (G)	-	-	W	-	W	-	-	-
Saw and sand	18	0.5	W	-	W	-	W	-
Chemicals (UG & G)	66	1.8	W	-	W	-	W	-
Fillers (G)								
Rubber, paints, etc.	35	1.0	W	-	W	-	W	-
Ceramic (G)								
Pottery, brick, e[illegible]	10	0.3	W	-	W	-	W	-

TABLE 5.3 (continued)

MAJOR USES OF SILICA PRODUCED IN
THE NORTHEASTERN UNITED STATES (1979-1983)
(U.S. BUREAU OF MINES MINERALS YEARBOOK)

Use	1980		1981		1982		1983	
	Thousand tonnes/a	%	Thousand tonnes/a	%	Thousand tonnes/a	%	Thousand tonnes/a	%
Filtration	65	1.8	49	1.6	65	2.1	10	0.3
Traction (engine)	15	0.4	16	0.5	16	0.5	11	0.4
Coal washing	2	-	W	-	W	-	W	-
Roofing granules and fillers	15	0.4	W	-	50	1.6	W	-
Fracturing	1	-	W	-	W	-	W	-
Miscellaneous	-	-	-	-	-	-	W	-
Other	303	8.3	764	24.2	514	16.7	1290	41.6
Gravel:								
Metallurgical:								
Silicon, ferrosilicon	-	-	-	-	W	-	-	-
Filtration	-	-	-	-	-	-	W	-
Other	-	-	-	-	97	3.2	-	-
TOTAL	3152*	100.0**	3661*	100.0**	3072*	100.0**	3104*	100.0**

Notes:

G - ground
UG - unground
W - withheld
Other - includes all withheld values

* Totals may not equal sum of individual quantities due to rounding

** Total may not be equal to 100.0 due to rounding

TABLE 5.4

MAJOR USES OF SILICA PRODUCED IN
THE SOUTHERN UNITED STATES (1979-1983)
(U.S. BUREAU OF MINES MINERALS YEARBOOK)

Use	1980		1981		1982		1983	
	Thousand tonnes/a	%	Thousand tonnes/a	%	Thousand tonnes/a	%	Thousand tonnes/a	%
Sand:								
Glassmaking:								
Containers	2520	29.0	2589	28.5	2599	30.7	1883	22.2
Flat	843	9.7	776	8.5	584	6.9	487	5.7
Specialty	546	6.3	385	4.2	215	2.5	196	2.3
Fibreglass (UG)	6	0.1	-	-	-	-	W	-
Fibreglass (G)	243	2.8	266	2.9	221	2.6	418	4.9
Foundry:								
Molding and core	1061	12.2	1714	18.9	1371	16.2	824	9.7
Facing	24	0.3	W	-	W	-	-	-
Refractory	45	0.5	33	0.04	W	-	W	-
Metallurgical:								
Silicon carbide	2	-	W	-	-	-	-	-
Flux	-	-	-	-	-	-	-	-
Abrasives:								
Blasting	1045	12.0	1118	12.3	1250	14.8	1064	12.6
Scouring (G)	68	0.8	W	-	W	-	W	-
Saw and sand	75	0.9	103	1.1	120	1.4	W	-
Chemicals (UG & G)	120	1.4	138	1.5	142	1.7	115	1.4
Fillers (G)								
Rubber, paints, etc.	88	1.0	71	0.8	W	-	45	0.5
Ceramic (G)								
Pottery, brick,	42	0.5	58	0.6	115	1.4	47	0.6

TABLE 5.4 (continued)

MAJOR USES OF SILICA PRODUCED IN
THE SOUTHERN UNITED STATES (1979-1983)
(U.S. BUREAU OF MINES MINERALS YEARBOOK)

Use	1980		1981		1982		1983	
	Thousand tonnes/a	%	Thousand tonnes/a	%	Thousand tonnes/a	%	Thousand tonnes/a	%
Filtration	81	0.9	100	1.1	120	1.4	59	0.7
Traction (engine)	127	1.5	122	1.3	162	1.9	35	0.4
Coal washing	28	0.3	W	-	W	-	W	-
Roofing granules and fillers	102	1.2	104	1.1	367	4.3	216	2.5
Fracturing	625	7.2	705	7.8	587	6.9	507	6.0
Miscellaneous	-	-	-	-	-	-	132	1.6
Other	337	3.9	263	2.9	320	3.8	1572	18.6
Gravel:								
Metallurgical:								
Silicon, ferrosilicon	550	6.3	459	5.0	209	2.5	W	-
Filtration	9	0.1	W	-	-	-	W	-
Grinding	-	-	-	-	-	-	-	-
Other	92	1.1	W	-	91	1.1	339	4.0
TOTAL	8681*	100.0**	9091*	100.0**	8473*	100.0**	8473	

Notes:

G - ground
UG - unground
W - withheld
Other - includes all withheld values

* Totals may not equal sum of individual quantities due to rounding

** Total may not be equal to 100.0 due to rounding

TABLE 5.5

PRIMARY USES FOR SILICA PRODUCED IN THE UNITED STATES (1982)

Submarket	Production Thousand tonnes/a	Primary Uses (in order except where noted)
Massachusetts	127	foundry
Rhode Island	5	molding and foundry use
Connecticut	73	—
New York	41	molding and foundry use
New Jersey	1945	glass products (over 50%), molds and cores, refractory, sandblasting, filtration
Pennsylvania	881	glass products (over 50%), molds and cores, refractories, fillers, other
Maryland	250 (est)	unknown
Virginia	900 (est)	glass, foundry, traction (not in order)
North Carolina	386 (sand)	glass, container, sandblasting, filtration and other (80%)
	265 (gravel)	ferrosilicon and other
South Carolina	654	molds and cores, glass, and fibreglass
Georgia	492	glass containers, miscellaneous, sandblasting, roofing granules
Florida	310	glass, foundry (markets in Alabama and Tennessee)
Alabama	870	molds and cores, silicon alloy
Mississippi	35	sandblasting, cores, molds
Louisiana	343	glass, foundry
Texas	2000	hydraulic fracturing, blasting, glass containers, ground fibreglass, flat glass and others

The Northeast has five uses which consume over 70 000 tonnes/a; the South, fifteen:

Northeast:

Glassmaking:	containers	1072 - 1789	thousand tonnes/a
Foundry:	molding and core	411 - 666	
Abrasives:	blasting	104 - 173	
Glassmaking:	specialty	131	
Filtration		10 - 65	

South:

Glassmaking:	containers	1883 - 2599	thousand tonnes/a
Foundry:	molding and core	824 - 1714	
Abrasives:	blasting	1045 - 1250	
Glassmaking:	flat	487 - 843	
Fracturing		507 - 705	
Silicon ferrosilicon (gravel)		209 - 550	
Glassmaking:	specialty	196 - 546	
Fibreglass (ground)		221 - 418	
Roofing granules and fillers		102 - 367	
Traction (engine)		35 - 162	
Chemicals (ground and unground)		115 - 142	
Filtration		59 - 120	
Abrasives:	saw and ground	75 - 120	
Ceramic:	pottery, brick, etc.	42 - 115	
Fillers:	rubber, paints, etc.	45 - 88	

4. The glass industry is based in New Jersey, Pennsylvania, Virginia, North Carolina, South Carolina, Georgia, Florida, Louisiana and Texas.

5. Foundries are concentrated in Massachusetts, Connecticut, New York, New Jersey, Pennsylvania, South Carolina and Alabama.

6. Hydraulic fracturing is used in the oil industry and consumes about 4-6 percent of American silica sand production. Consumption is concentrated in Texas (where it is the leading use of silica) and, likely, Louisiana. It is usually used to enhance production from oil fields which are nearing depletion. (In Canada, Alberta would be the prime market for fracturing sand, fields such as Hibernia, would not).

5.3 Canada

Canada's silica consumption is centered in Quebec and Ontario. Presented in Table 5.6 are the major consumptive uses of silica (domestically produced and imported) in the two provinces, plus the consumption of domestically-produced silica for Canada.

Observations:

1. Much of the domestic production goes for Class 2 uses such as flux.

2. In Quebec, the major use categories are:

Glass	228.0 thousand tones/a
Foundry	102.2
Silicon carbide	76.6

TABLE 5.6

MAJOR USES OF SILICA IN QUEBEC AND ONTARIO (1981)

Use	QUEBEC (Domestic and Import) Thousand Tonnes/a	%	ONTARIO (Domestic and Import) Thousand Tonnes/a	%	CANADA (Domestic Only Thousand Tonnes/a	%	(Domestic and Import) Thousand Tonnes/a	%
Glassmaking:								
Container	228.0	42.1	360.0	27.9				
Flat			260.0	20.1	489.0	21.8	951.4	30.9
Fibreglass	33.2	6.1	42.6	3.3				
Foundry	102.2	18.8	330.0	25.6	-	-	468.0	15.2
Refractory brick	-	-	140.0	10.9	-	-	359.2	11.7
Chemical:								
Sodium silicate	12.7	2.3	20.0	1.5	-	-	39.4 (chemicals) 1.3	
Metallurgical:								
Ferrosilicon	-	-	-	-	339.0	15.1	132.4	4.7
Silicon carbide	76.6	14.1	58.2	4.5	-	-	125.7	4.1
Flux	-	-	-	-	837.0	37.4	724.0	23.5
Abrasives:								
Sandblast	45.0	8.3	-	-	-	-		
Asbestos-cement	7.5	1.4	-	-	-	-		
Concrete products	-	-	-	-	-	-	211.6	6.9
Others	37.0	6.8	81.0	6.3	573.0	25.6	56.4	1.8
TOTAL	542.2*	100.0**	1290.0*	100.0**	2238.0*	100.0**	3079.2*	100.0*

* Total may not be equal to sum of parts due to rounding

** Total may not be equal to 100.0 due to rounding

3. In Ontario, the major use categories are:

Glass containers	360.0
Foundry	330.0
Flat glass	260.0
Refractory brick	140.0

4. Assuming a maximum 10 percent market share and a minimum shipload of 7000 tonnes per silica type, only those uses listed in (2) and (3) above could be targeted by Nova Scotia and New Brunswick suppliers. This is a preliminary evaluation which could be altered by price or quality considerations.

6. PRICES AND COSTS

6.1 Introduction

As businessmen, silica producers want to maximize gross profit on sales. Gross profit is a function of unit margin between price and cost and the volume of product sold. (Volume is discussed under Section 5. Potential Markets.)

Three elements were investigated in the analysis of margin: product cost for New Brunswick and Nova Scotia producers, product cost for existing producers in export markets, and selling price.

Product cost for New Brunswick and Nova Scotia producers was determined because it represents the base figure which the producers must control to stay in business. Product cost for existing producers in export markets was determined because it represents the limit to which these producers can lower prices in a long-term price competition.

Price was analyzed because it represents the current market value for aggregate products and is the unit return a New Brunswick or Nova Scotia producer will get for his aggregate, regardless of his costs.

6.2 Product Costs - New Brunswick and Nova Scotia Producers

At present, there is only one producer of silica in New Brunswick (Chaleur Silica Ltd.) and one in Nova Scotia (Nova Scotia Sand and Gravel). Neither operation can be considered a typical silica operation or a model for the type of efficient operation which would be required to compete on the American, Quebec, or Ontario markets. Chaleur Silica Ltd. is too small, and Nova Scotia Sand and Gravel treats silica as a by-product.

Therefore, it is necessary to estimate product costs for a New Brunswick or Nova Scotia producer using other sources. The best source is the U.S. Census (see Table 6.1) which yields average production costs of $12.44/tonne for the United States, $17.59/ tonne for New Jersey, and $13.35/tonne for Texas. Average selling prices for the same period are $17.33/tonne for the United States, $19.29/tonne for New Jersey, and $23.98/tonne for Texas; thus the average profits are $4.89/ tonne (39 percent) for the United States, $1.70/tonne (10 percent) for New Jersey, and $10.65/tonne (80 percent) for Texas. These values are for 1982 and are not adjusted for inflation.

Statistics Canada produces similar information. Unfortunately, the cost factors for silica are grouped with those of other producers under the heading of "other non-metals mines". As a rough estimate we can use the average values (see Section 6.3.2) for silica produced in Canada ($18.71/tonne), Quebec ($19.22) and (Ontario $18.78). These values include profit and are therefore overstated by that amount. They are 1982 values and are not adjusted for inflation.

The final information source is the "best price" offered by a large producer. It is known that an Illinois producer charged $9.27/tonne (Canadian) in 1981 and it reported that it is selling sand for $8.50 in 1985. This is material from a very large crushed stone operation.

TABLE 6.1

PRODUCTION COSTS (CANADIAN $/TONNE)
FOR INDUSTRIAL SAND AND GRAVEL IN THE UNITED STATES (1982) INFLATION IGNORED
(1982 CENSUS OF MINERAL INDUSTRIES
1982 U.S. BUREAU OF MINES MINERAL YEARBOOK)

Cost Component	United States		New Jersey		Texas	
	$	$/tonne	$	$/tonne	$	$/tonne
Cost of Labour:						
Wages	73.5	3.06	7.9	4.05	6.0	3.0
Supplemental labour costs (Social Security, etc.)	25.2	1.05	2.4	1.23	2.0	1.00
Cost of Supplies:						
Supplies, minerals, machinery	115.2	4.80	12.4	6.36	12.7	6.35
Fuel	47.6	1.98	5.9	3.03	3.5	1.75
Electricity	35.9	1.50	5.6	2.87	2.4	1.20
Cost of Services:						
Communication services	1.1	0.05	0.1	0.05	0.1	0.05
TOTAL	298.5	12.44	34.3	17.59	26.7	13.35
Average selling price	$17.33		$19.29		$23.98	

There is a great variation amongst these "typical" production costs. To account for this variation, two product costs have been assumed: the first is a "best case" estimate representing the cost of an ideal deposit (sand, little overburden, clean, well-graded, high quality) while the second is a "worst case" estimate representing the cost of a difficult deposit (rock, crushing required, heavy overburden, some upgrading required). The "best case" estimate is set at $8.00/tonne; the "worst case" $20.00/tonne.

6.3 Product Costs - Existing Producers in Export Market

6.3.1 United States

Presented in Tables 6.2 and 6.3 are industrial sand and gravel product shipment values of various states and different uses for the period 1977 to 1984.

These values are not costs in the strict sense of the word, as they represent the prices for which producers sell their product at the plant. These values include profit, discounts, and allowances. However, they exclude freight charges, and thus, do not represent the price at the consumer's destination which is the price against which New Brunswick and Nova Scotia producers would have to compete.

Since four consecutive years of information is presented in Tables 6.2 and 6.3, the figures have not been adjusted for inflation. However, analysis of the changes in values reveals the following annual inflation rates (compound):

TABLE 6.2

PRODUCT SHIPMENT VALUES (CANADIAN $/TONNE)*
FOR INDUSTRIAL SAND AND GRAVEL IN THE AMERICAN MARKET (1979-1984)--INFLATION IGNORED
(1977 AND 1982 CENSUS OF MINERAL INDUSTRIES AND
1981-1984 BUREAU OF MINES MINERALS YEARBOOK)

State	1977 Census			1982 Census			Minerals Yearbook			
	Glass	Molding	NEC**	Glass	Molding	NEC**	1981	1982	1983	1984
Massachusetts	-	-	-	-	-	-	-	16.95	-	-
Rhode Island	-	-	-	-	-	-	4.40	14.67	-	-
Connecticut	-	-	-	-	-	-	37.65	32.03	49.25	-
New York	-	-	-	-	-	-	-	16.79	16.79	-
New Jersey	-	11.24	7.63	17.60	13.93	-	16.82	19.29	19.55	19.33
Pennsylvania	-	-	-	-	-	-	19.33	20.56	21.00	-
Maryland	-	-	-	-	-	-	-	-	-	-
Virginia	-	-	-	-	-	-	11.00	17.22	15.60	-
North Carolina	-	-	-	-	-	-	12.38	9.99	16.09	16.02
South Carolina	-	-	-	-	-	-	19.23	22.21	22.94	24.51
Georgia	-	-	-	-	-	-	-	18.41	19.87	20.96
Florida	-	-	-	-	-	-	18.57	18.30	15.37	15.66
Alabama	-	-	-	-	-	-	6.97	12.36	11.41	10.16
Mississippi	-	-	-	-	-	-	-	19.67	18.88	-
Louisiana	-	-	-	-	-	-	20.15	17.81	21.43	21.02
Texas	10.51	6.60	18.16	-	11.00	30.31	24.20	23.97	24.32	21.60
Illinois	6.45	9.38	19.95	10.93	14.99	30.98	15.53	16.79	15.49	-
Michigan	-	10.69	5.26	-	11.12	9.64	9.94	11.02	11.41	-
United States	8.82	9.59	14.35	17.11	13.59	28.68	16.26	17.33	18.47	-

* FOB mine or plant after discounts and allowances, excluding freight charges (inflation ignored, 1 tonne = 1.1 short ton; 1 Can.$ = $0.75 U.S.$)

** NEC - not elsewhere classified

TABLE 6.3

PRODUCT SHIPMENT VALUES (CANADIAN $/TONNE)*
BY USE FOR INDUSTRIAL SAND AND GRAVEL IN THE AMERICAN MARKET
(1980-1983)--INFLATION IGNORED
(BUREAU OF MINES MINERAL YEARBOOK)

Use	Northeast**				South***			
	1980	1981	1982	1983	1980	1981	1982	1983
Sand:								
Glassmarking:								
Containers	14.17	17.09	18.89	18.19	12.00	14.07	16.63	17.29
Flat	16.13	17.64	18.99	18.38	10.84	13.46	13.93	15.83
Specialty	16.65	18.04	19.33	18.63	11.18	15.03	15.27	16.59
Fibreglass (UG)	12.07	15.31	20.49	16.13	11.10	-	-	37.09
Fibreglass (G)	13.46	15.14	18.98	51.33	28.12	32.79	36.92	30.76
Foundry								
Molding, core	17.54	17.10	18.13	15.61	11.25	9.78	14.18	13.80
Facings	13.83	23.91	15.74	22.98	12.92	14.95	26.11	-
Refractory	24.45	26.52	32.75	37.40	16.49	19.15	21.27	23.60
Metallurgical								
Silicon carbide	22.00	26.77	26.84	36.67	13.93	W	-	-
Flux, smelting	-	-	-	-	-	-	-	-
Abrasives								
Blasting	18.17	24.99	21.22	29.23	19.62	22.89	21.57	23.55
Scouring (G)	W	W	W	-	26.87	29.13	32.40	31.50
Saw and sand	10.93	11.28	19.55	32.27	13.14	12.58	10.34	-

TABLE 6.3 (continued)

PRODUCT SHIPMENT VALUES (CANADIAN $/TONNE)*
BY USE FOR INDUSTRIAL SAND AND GRAVEL IN THE AMERICAN MARKET
(1980-1983)--INFLATION IGNORED
(BUREAU OF MINES MINERAL YEARBOOK)

Use	Northeast**				South***			
	1980	1981	1982	1983	1980	1981	1982	1983
Chemicals (G & VG)	16.12	17.50	18.55	17.79	18.76	20.39	20.28	23.06
Fillers (G)								
Rubber, paints, putty	39.86	63.67	69.39	98.74	46.98	56.64	61.42	84.80
Ceramics (G)								
Pottery, brick, tile, etc.	35.60	38.24	40.98	62.17	30.70	31.37	16.29	38.98
Filtration	22.45	28.98	20.24	34.67	13.64	13.30	13.74	11.10
Traction (engine)	15.36	17.28	17.76	17.60	9.80	9.65	9.17	14.02
Coal washing	13.20	19.07	14.67	13.93	13.01	13.30	13.90	30.80
Roofing granules and fillers	22.95	25.42	17.47	24.20	20.47	22.43	12.66	17.17
Hydraulic fracturing	16.13	27.87	22.00	-	31.03	35.38	38.22	32.82
Miscellaneous	-	-	-	17.47	-	-	-	16.07
Gravel:								
Metallurgical								
Silicon ferrosilicon	-	-	W	-	10.82	12.79	14.36	12.99
Filtration	-	-	-	31.91	5.72	12.72	6.12	27.87
Grinding	-	-	W	-	-	-	13.01	-
Other	-	-	21.09	-	6.57	7.01	12.10	13.86
Average average	15.31	17.97	19.81	20.42	15.21	17.28	18.70	19.62

TABLE 6.3 (continued)

PRODUCT SHIPMENT VALUES (CANADIAN $/TONNE)*
BY USE FOR INDUSTRIAL SAND AND GRAVEL IN THE AMERICAN MARKET
(1980-1983)--INFLATION IGNORED
(BUREAU OF MINES MINERAL YEARBOOK)

Notes: G - ground, UG - underground

Northeast includes Maine, New Hampshire, Vermont, Massachusetts, Rhode Island, Connecticut, New York, New Jersey and Pennsylvania.

South includes Maryland, Delaware, Virginia, West Virginia, North Carolina, South Carolina, Kentucky, Tennessee, Georgia, Florida, Alabama, Mississippi, Louisiana, Arkansas, Texas and Oklahoma.

		Northeast	South
Use:	Overall Average	7.5%	6.5%
(1980-1983)	Glassmaking: containers	6.0	10.0
	Foundry: molding, core	-3.0	5.0
	Abrasives: blasting	13.0	5.0
	Other	19.5	9.0
State:	New Jersey	3.5%	
(1981-1984)	North Carolina	6.5	
	South Carolina	6.5	
	Florida	-4.0	
	Alabama	10.0	
	Louisiana	1.0	
	Texas	-3.0	

It appears that values have levelled off in the mid-1980s after a period of steady increases in the early 1980s. Thus, an annual inflation factor of 5 percent should be adequate to adjust to 1985 values.

Using 5 percent inflation, a preliminary screen of uses was conducted on the American market. A cutoff point of $23.00 was used ($8.00/tonne (production) + $15.00/tonne (transportation) for New England and $26.00 ($8.00/tonne production and $18.00/tonne (transportation) for the south (both Canadian $/tonne (1985). These prices represent minimum cost for a New Brunswick or Nova Scotia supplier to compete in the northeastern and southern markets. As shown in Table 6.4, the range of silica uses for which New Brunswick and Nova Scotia suppliers could compete is reduced substantially when these criteria are used. Of special consideration is the loss of many of the largest silica uses: glass containers, flat glass, specialty glass, fiberglass (in Northeast), foundry: molding and core, roofing granules and fillers (in South), abrasives: blasting (in South) and "other uses" (in South). This means that unless consumers

TABLE 6.4

ESTIMATED CURRENT SHIPMENT VALUES* FOR INDUSTRIAL SAND AND GRAVEL USES IN THE UNITED STATES (SCANADIAN/TONNE (1985))

Use	Value	
	Northeast	South
Sand:		
Glassmaking:		
Fibreglass (G)	-	40.89
Fibreglass (UG)	56.59	33.91
Foundry:		
Facings	25.34	30.23
Refractory	41.23	26.02
Metallurgical:		
Silicon carbide	36.67	-
Abrasives:		
Blasting	32.22	-
Scouring (G)	-	34.73
Saw and sand	35.58	-
Fillers: (G)	108.86	93.49
Ceramics: (G)		
Pottery, brick, tile, etc.	68.54	42.98
Filtration:	-	33.96
Coal washing:	-	33.96
Roofing granules and fillers:	26.68	-
Hydraulic fracturing:	24.26	36.18
Other:	24.82	-
Gravel:		
Filtration	35.18	30.73

*Assuming 5 percent annual inflation for 1983 and 1984 and cut-off of $23 (Canadian)/tonne for New England and $26 (Canadian)/tonne for the south.

are paying very high transportation costs from pit to their plant, New Brunswick and Nova Scotia producers could not compete with local suppliers for at least 50 percent of the northeastern market and 70 percent of the southern market in event of a "price war."

6.3.2 Quebec and Ontario

Unfortunately, the information available on silica costs for Quebec and Ontario are not as detailed as those for the United States. Table 6.5 presents silica values for the two provinces and Canada for the years 1979 to 1982.

The values have not been adjusted for inflation. Analysis of the data shows that values increased 7.0 percent annually in Quebec, 20.0 percent in Ontario, and 13.5 percent in Canada. It is interesting to notice that the biggest price increase for Ontario occurred the same year (1982) that its production dropped by 50 percent. It is likely that values have moderated since 1982, as they have done in the United States. To adjust values to 1985, an inflation factor of 5 percent was used.

No information is available on cost variation with end use. This is unfortunate, as the average prices presented in Table 6.5 are below the cost for which New Brunswick and Nova Scotia producers could supply the Quebec and Ontario markets.

Large volumes of silica are imported to Ontario and Quebec, much of it from Michigan and Illinois. Table 6.5 also presents production values for these important import sources.

TABLE 6.5

SILICA VALUES (CANADIAN $/TONNE)
FOR QUEBEC AND ONTARIO, 1979-1982 (INFLATION IGNORED)
AND 1985 (INFLATION ADJUSTED) (STATISTICS CANADA)

Market	1979	1980	1981	1982	1985
Quebec	14.71	15.68	18.66	19.22	22.25
Ontario	9.15	10.22	12.18	18.78	21.74
Canada	11.22	12.96	15.50	18.71	21.66
Michigan	-	-	9.94	11.02*	12.76
Illinois	-	-	15.53	16.79**	19.44

* By type: Molding $11.12, NEC $9.64

** By type: Glass $10.93, Molding $14.99, NEC $30.98

6.4 Comparison of Production Costs

It is difficult to compare production costs for New Brunswick and Nova Scotia producers to those for the United States, Quebec, and Ontario. First of all, there are no producers in New Brunswick and Nova Scotia set up for export sales, thus production costs have been estimated. Secondly, many of the producers in the United States, Quebec and Ontario are quite large; certainly the largest portion of silica demand is met by large producers. This means that the larger firms could have advantages of scale over the New Brunswick or Nova Scotia producer.

In general, it can be said that New Brunswick and Nova Scotia producers would:

1. Tend to experience product costs equal to those elsewhere for the same size of operation;

2. Tend to have smaller operations and higher costs than most of the American, Ontario and Quebec producers;

3. Would experience lower costs only in the event of favourable geological or geographic conditions (for example, the Lockhart deposit, being a sand, has decided advantage over a rock deposit. The Cape Spencer deposit has an advantage because it is located close to a port (Saint John));

4. Would find it difficult to compete for Class 2 silica markets because of prices.

5. Would have to compete for the Class 1 silica markets by offering better value for money.

6.5 Prices in Export Market

6.5.1 United States

There is little published information which tells the price consumers pay for silica delivered. It is known that quartz for gardening use costs $75/tonne (Canadian),* but this is a low volume application of silica.

In the absence of published information, a telephone survey was conducted. The survey yielded the following information:

- Foundries in northern New England (Massachusetts, Maine, New Hampshire, Vermont) can purchase sand for $21.90 per tonne from a source in Masschusetts. Freight is extra. Sand is delivered by blower trucks. (Information source uses 45 tonnes per week).

- One foundry in southern New England (Connecticut, Rhode Island) reported a delivered price for sand of $94.00 per tonne. The sand is delivered in dump trucks and originates in New Jersey. The foundry uses 23 tonnes per week.

- Many foundries in New England have either shut down or curtailed production, thus foundry sand market and prices are depressed.

- Foundries in Texas report a sand price of $13.30 per tonne, undelivered. Consumption varies between 225 and 2100 tonnes per week. The sand came from sources in the state.

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*Source: Means Site Work Cost Data. All prices presented here are in Canadian dollars.

- In Florida, one foundry reports a price of $16.60 per tonne, delivered. It uses about 350 tonnes per week. Another foundry reports a price of $5.80 per tonne, undelivered. The sand comes from sources in the state.

- Foundries in Florida and Texas are experiencing rough times, with closures and employee layoffs common.

- Most "glass" manufacturers in New England are secondary manufacturers and rework glass purchased from primary glass producers. The primary glass producers are located in New Jersey, Illinois, North Carolina, and South Carolina--states with large silica deposits.

- Because of close proximity of glass plants to silica sources, transportation costs are low, and prices are likely close to those presented in Section 6.3.

- One large Pennsylvania-based glass manufacturer, which obtains its silica from Ohio, reports a price of $17.00/tonne, undelivered. Owning six plants throughout the United States, the firm uses 0.75 M tonnes of silica annually.

- Another large Pennsylvania-based manufacturer obtains silica for its five plants from southern New Jersey, Pennsylvania, central Ohio, and northern Illinois. The sand costs $15.00/tonne, undelivered, for amber glass and $10.00-$17.00 per tonne, undelivered, for flint glass. Its plants are located throughout the midwest and mid-Atlantic regions. Total annual consumption for the plants is 0.32 M tonnes (flint) and 0.05 M tonnes (amber).

- A third Pennsylvania plant would not divulge its silica cost but stated that it used 0.02 M tonnes per year. Its source was a pit in Pennsylvania.

- The silicon carbide industry is in depressed circumstances due to downtown in primary metal industries. As a result, it appears that only plants manufacturing primary silicon carbide are in Canada and Niagara Falls, NY (see Section 6.5.2).

6.5.2 Quebec and Ontario

Price information for Quebec and Ontario came from two sources:

- La Silice Dans L'Est Canadien - Etude de Marché (Silica in Eastern Canada - A Market Study) by N. Pham Phu, Albert Bonchard, and Réal Allen. A report prepared for the Government of Quebec in April 1983.

- Telephone calls to primary consumers in Quebec and Ontario (see Table 6.6).

Observations.

- There has been little change in prices since 1981. This is due likely to the recession in primary industry during the 1981-83 period.

- The delivered prices paid by customers are often much higher than the values reported by producers at the pit or plant. Examples:

foundry	200 - 600 percent higher
sandblast	400 - 450 percent higher
sodium silicate	200 - 250 percent higher
silicon carbide	2002 - 250 percent higher

TABLE 6.6

PRICES (DELIVERED) PAID BY SILICA CONSUMERS
IN QUEBEC AND ONTARIO (CANADIAN $/TONNE)

Consumer	"Etude de Marché" (1981)	Information Source Telephone (1985)
Glass:		
Quebec	28.50 - 30.00 (L)	-
Ontario	49.66 (I)	
	39.60 (L)	37.00 - 40.00 (L)
Fibreglass:		
Quebec	23.00 - 30.00 (L)	< 24.00
Ontario	-	
Foundry:		
Quebec	41.00 - 120.00 (I)	72.00 (I)
	7.30 - 27.30 (L)	
Ontario	12.20 (L)	15.00 - 20.00 (L)
Silicon Carbide:		
Quebec	42.80 - 43.40 (I)	-
	29.10 - 35.14 (L)	
Ontario	52.10 (I)	> 30.00 (I)
Abrasives: sandblast		
Quebec	80.00 - 90.00 (I)	-
	23.00 - 40.00 (L)	-
Ontario	-	
Sodium Silicate		
Quebec	40.00 - 50.00 (I)	-
Ontario	-	40.00 - 45.00 (I)
Asbestos-cement		
Quebec	31.50 - 32.50 (L)	-
Ontario	-	-
Others		
Quebec		
Ontario	-	400.00 (I)*

L - local
I - imported

*2 t/a

- The higher prices are likely a function of the following factors:

  small-order quantities - foundry, sandblast, others
  long-haul distances - foundry, sandblast, others
  high specified quality - silicon carbide, sodium silicate, glass

- New Brunswick and Nova Scotia producers should be able to match or better these prices at large ports (Quebec, Montreal, Toronto, Hamilton).

6.6 Potential Price Margins for New Brunswick and Nova Scotia Producers

Because of the uncertainty regarding production costs for New Brunswick and Nova Scotia suppliers, estimates of potential price margins will be uncertain.

With this uncertainty in mind, "best case" and "worst case" margins were generated. The "best case" estimates are presented in Tables 6.9 and 6.10. The "best case" New Brunswick and Nova Scotia price assumed the lowest cost scenario of an easily mined silica sand deposit located in Sussex, N.B. and Shubenacadie, N.S. ($8.00/tonne + transportation and handling to nearest port). For the United States markets, price values were those presented in Table 6.4, while for Quebec and Ontario, price values were those presented in Table 6.6.

For the worst case scenario, the same procedure was followed except production cost was raised by $12.00/tonne to $20.00/tonne (see Tables 6.7 and 6.8).

From the two analyses, the following observations can be made:

TABLE 6.7

POTENTIAL PRICE MARGINS (CANADIAN $/TONNE)
FOR NEW BRUNSWICK AND NOVA SCOTIA PRODUCERS
IN THE UNITED STATES MARKETS (WORST-CASE CONDITIONS)

	North East (Philadelphia)		South (Savannah)	
Use	Sussex ($35.39/tonne)	Shubenacadie ($35.91/tonne)	Sussex ($37.49/tonne)	Shubenacadie ($38.00/tonne)
Sand:				
Glassmaking:				
Fibreglass (G)	-	-	3.40	2.89
Fibreglass (UG)	21.20	20.68	-	-
Foundry:				
Facings	-	-	-	-
Refractory	5.84	5.32	-	-
Metallurgical:				
Silicon carbide	1.28	0.76	-	-
Abrasives:				
Blasting	-	-	-	-
Scouring (G)	-	-	-	-
Saw and sand	0.19	-	-	-
Fillers (G)	73.47	72.95	56.00	55.49
Ceramics (G):				
Pottery, brick, tile, etc.	33.15	32.63	5.49	4.98
Filtration	-	-	-	-
Coal washing	-	-	-	-
Roofing granules and fillers	-	-	-	-
Hydraulic fracturing	-	-	-	-
Other	-	-	-	-
Gravel:				
Filtration	-	-	-	-

TABLE 6.8

POTENTIAL PRICE MARGINS (CANADIAN $/TONNE)
FOR NEW BRUNSWICK AND NOVA SCOTIA PRODUCERS
IN THE QUEBEC AND ONTARIO MARKETS (WORST-CASE CONDITIONS)

Use	Quebec (Montréal) Sussex ($37.51/tonne)	Quebec (Montréal) Shubenacadie ($35.53/tonne)	Ontario (Toronto) Sussex ($40.66/tonne)	Ontario (Toronto) Shubenacadie ($38.68/tonne)
Glass	-	-	9.00 (I) -	10.98 (I) 0.92 (L)
Fibreglass	-	-	-	-
Foundry	2.49-82.49 (I) -	5.47-84.47 (I) -	-	-
Silicon carbide	5.29- 5.89 (I) -	7.27- 7.87 -	11.44 (I)	13.42 (I)
Abrasives: sandblast	42.49-52.49 (I) 0 - 2.49 (L)	42.47-52.47 (I) 0 - 4.47 (L)	-	-
Sodium silicate	2.49-12.49 (I)	4.47-14.47 (I)	0- 4.34 (I)	1.32- 6.32 (I)
Asbestos-cement	-	-	-	-
Others	-	-	-	-

TABLE 6.9

POTENTIAL PRICE MARGINS (CANADIAN $/TONNE)
FOR NEW BRUNSWICK AND NOVA SCOTIA PRODUCERS
IN THE UNITED STATES MARKETS (BEST-CASE CONDITIONS)

	North East (Philadelphia)			South (Savannah)
Use	Sussex ($25.39/tonne)	Shubenacadie ($23.91/tonne)	Sussex ($25.49/tonne)	Shubenacadie ($26.00/tonne)
Sand:				
Glassmaking:				
Fibreglass (G)	-	-	15.40	14.89
Fibreglass (UG)	33.20	32.68	8.42	7.91
Foundry:				
Facings	1.15	0.63	4.74	4.23
Refractory	17.84	17.32	0.53	0.02
Metallurgical:				
Silicon carbide	13.28	12.76	-	-
Abrasives:				
Blasting	8.83	8.28	-	-
Scouring (G)	-	-	9.24	8.73
Saw and sand	12.19	11.67	-	-
Fillers (G)	85.47	84.95	69.00	67.49
Ceramics (G):				
Pottery, brick, tile, etc.	45.15	44.63	17.49	16.98
Filtration	-	-	8.47	7.96
Coal washing	-	-	8.47	7.96
Roofing granules and fillers	3.29	2.77	-	-
Hydraulic fracturing	0.87	0.35	10.69	10.18
Other	1.43	0.91	-	-
Gravel:				
Filtration	11.79	11.27	5.24	4.73

TABLE 6.10

POTENTIAL PRICE MARGINS (CANADIAN $/TONNE)
FOR NEW BRUNSWICK AND NOVA SCOTIA PRODUCERS
IN THE QUEBEC AND ONTARIO MARKETS (BEST-CASE CONDITIONS)

Use	Quebec (Montréal) Sussex ($25.51/tonne)	Quebec (Montréal) Shubenacadie ($23.53/tonne)	Ontario (Toronto) Sussex ($28.66/tonne)	Ontario (Toronto) Shubenacadie ($26.68/tonne)
Glass	2.99- 4.49 (L)	4.97- 6.47 (L)	21.00 (I) 10.94 (L)	22.98 (I) 12.92 (L)
Fibreglass	0 - 4.49	0 - 6.47	-	-
Foundry	14.49-94.49 (I) 0 - 1.79 (L)	17.47-96.47 (I) 0 - 3.77 (L)	-	-
Silicon carbide	17.29-17.89 (I) 3.59- 9.63 (L)	19.27-19.87 (I) 5.57-11.61 (L)	23.44 (I)	25.42 (I)
Abrasives: sandblast	54.49-64.49 (I) 0 -14.49 (L)	56.47-66.47 (I) 0 -16.47 (L)	-	-
Sodium silicate	14.49-24.49 (I)	16.47-26.47 (I)	11.34-16.34 (I)	13.32-18.32
Asbestos-cement	5.99- 6.99 (L)	7.97- 8.97 (L)	-	-
Others	-			

6.6.1 United States

1. The only uses with large profit margins are low volume uses such as fillers and ceramics.

2. Many of the uses require ground silica. Grinding silica would raise the production cost.

3. Many uses have acceptable margins in the Northeast but not in the South. The reverse is true as well.

4. Under worst-case conditions, the number of uses with a profit margin decrease from twelve to six in the Northeast and from eleven to three in the South.

6.6.2 Quebec and Ontario

1. The only uses with large profit margins are those used in small volumes by many users (sandblasters, foundries).

2. The highest margins are those for imported silica. If New Brunswick or Nova Scotia silica can command prices similar to imported material, suppliers will earn a good return.

3. New Brunswick and Nova Scotia producers would find it difficult to compete against local producers.

4. Under worst-case conditions, the number of uses with a profit margin decrease from seven to four in Quebec. There is no decrease in Ontario.

7. TRANSPORTATION OF SILICA MATERIALS

7.1 Introduction

In the previous chapters, the range of silica uses and material specifications corresponding to those uses, the active and potential silica sources throughout Nova Scotia and New Brunswick, and the prospective markets and cost/price structures of silica materials have been detailed. This chapter reports the various means of transporting silica to the prospective markets and the associated haulage and handling costs.

The availability of surplus silica resources produced at costs less than market prices may not ensure its economic viability. Market prices are dependent upon the production costs plus the costs of delivery to the market. The costs of delivery becomes proportionally more significant as the distance between source and market becomes more remote. However, as existing silica resources located in closer proximity to the markets deplete or entail higher production costs, more remote sources with lower production costs may become economic. In this perspective the costs of the long-haul transportation of silica materials to prospective markets becomes a primary determinant of the viability of the potential operation.

Silica materials are relatively low valued commodities which require bulk haul transporting equipment. Normally large-scale transportation operations are set up to haul bulk commodities as economically as possible, because transportations costs constitute such a large portion of the delivered price. However, due to the heterogeneity of silica materials, as specified for their various uses, the high volumes required between producer and consumer to utilize dedicated transportation systems may not be available. Markets for silica materials are generally fragmented by the material specifications required by the consumer,

and each silica source may not be suitable to supply all consumer uses. In addition, silica materials connot be exposed to rain or snow and require coverage while in transit. These factors, among others, will affect the final negotiated freight rates of silica between the shipper and selected carrier.

Three potential transport modes are considered in this analysis:

1. for-hire trucking mode;

2. rail and/or truck-to-rail mode; and

3. marine shipping and/or truck-to-marine mode.

A special case of moving silica from its source to a marine port by rail for transhipment to a bulk self-unloading vessel (i.e., rail-to-marine mode) will also be examined.

Transport costs have been attained for each of these transport modes from several silica sources located throughout Nova Scotia and New Brunswick to selected prospective foreign and domestic market centres. Since silica consumers are dispersed throughout the selected market areas, market centres have been chosen as proxies to their actual user destination in determining representative freight rates for this analysis. The physical distribution of silica to the consumers at the end destinations are often handled by silica wholesale distributers, which for the purpose of this analysis, would constitute the consumer market.

Freight rates for relatively low valued bulk commodities, as slica materials, are determined from a complex of factors which include:

1. length and minimum operating cost of haul;

2. value and nature of commodity hauled;

3. annual volume, frequency and regularity of haul;

4. transport equipment availability and capital depreciation;

5. backhaul availability;

6. loading and unloading requirements;

7. intramodal and intermodal competition;

8. length of contract;

9. minimum load quantity or load factor;

10. layover or berthing time charges; and

11. general economic market conditions.

As such, freight rates at times can be volatile or at least unpredictable. Determining a representative freight rate often requires detailed examination of the above array of variables. For a given mode and commodity under different sets of conditions freight rates may be set below actual operating costs or with extreme excess profits.

Freight rate analysts and agencies representing each mode were contacted and the above considerations discussed. In general, they were hesitant to commit themselves to negotiated contract freight rates due to the nature of this feasibility study, the

uncertainty of the actual parameters, the lack of guarantee of a contract, and the start-up time of the potential business venture. However, they all were willing to produce representative freight rates under normal conditions as would apply to the commodity movements for 1985 prior to negotiating a specific contract. Therefore, the transport costs given in this report are to be viewed as representative rates, which are forwarded to the shipper at the onset of negotiations or presented for feasibility analyses purposes by freight rate analysts. This implies that they may be higher than negotiated contract freight rates with the carriers should business materialize.

The remainder of this sections is divided into two sections:

1. silicia transportation to foreign markets; and

2. silica transportation to domestic markets.

7.2 Silica Transportation to Foreign Markets

7.2.1 Introduction

In this section, the costs of transporting silica materials are tabulated for movements from the sources within Nova Scotia and New Brunswick to prospective market centres throughout the eastern and southeastern United States. Transport costs have been calculated in both $ U.S. and $ Can., for all silica export movements at a foreign exchange rate of $1.00 U.S. = $1.35 Can.

The following subsections report the carrier means and transport costs for each of the three available transport modes: trucking, rail and marine. Respective freight rates were acquired from the following sources:

1. For-Hire Truck Freight Rates: from Nova Scotia and New Brunswick Haulage Rates for sand and gravel; from Atlantic Provinces Transportation Commission (A.P.T.C.) representative bulk commodity freight rates for hauling sand and gravel, limestone, and other aggregate materials, as offered by a sample of for-hire trucking operators; and estimated silica sand haulage rates from Kingsco Transport.

2. Rail Freight Rates: from CN Rail estimated representative rates for silica sand haulage; and from A.P.T.C. representative bulk commodity rail freight rates for burned shale, coal and limestone movements.

3. Marine Freight Rates: from A.P.T.C. representative marine bulk commodity freight rates from a sample of Canadian steamship brokers; representative transhipment/loading costs from Ports Canada and a sample of stevedoring companies at the Port of Saint John; and silica freight rate verification and self-unloader vessel carriage information from Canada Steamship Lines Inc.

The conditions applicable to the transport freight rates will be outlined in the following discussions of transport costs by transport mode(s).

7.2.2 Silica Transportation by Trucking Mode

For-hire truck rates are presented on a per tonne-kilometre basis with minimum load of 23 tonnes. The truck configuration normally used to haul crushed stone or sand and gravel is a 35 tonne tandem triaxle, which in this case would be loaded to its maximum 35 tonne payload. As silica materials generally must be kept free of moisture, use of tarps covering the truck boxes would be required.

In calculating truck transport costs, the minimum primary highway distances from the silica sources to the export market centres were used. This included the use of ferry crossings via the Yarmouth to Bar Harbour ferry for movements in Nova Scotia where its use was more economical than routing through New Brunswick. The Yarmouth to Bar Harbour ferry offers a once daily service from mid-May to mid-September and three times weekly during the remainder of the year. Round trip costs for the foremention ed truck configuration were $8.96 U.S. per tonne.

Tables 7.1 and 7.2 show the trucking costs in $ U.S. and $ Can., respectively, of silica materials from silica sources in Nova Scotia and New Brunswick to selected prospective export market centres of eastern United States. The origins given in these tables represent the source(s) in that vicinity, as were given in Sections 3.2 and 4.2. For instance, West Beach/Cape Spencer, Burchill Road and Drury Cove are all found in the vicinity of Saint John.

Table 7.1 shows that for-hire truck transport costs range from a low of $20.37 U.S. from Chegoggin to Portland via the Yarmouth - Bar Harbour Ferry to a high of $159.69 U.S. from the George River/Leitches Creek deposits near Sydney to Savannah, Georgia.

Although the trucking mode is not normally the mode utilized for medium-to-high volume, relatively low valued bulk commodities for long hauls, truck does offer some advantages. The major advantage of the long-haul transport of silica by truck is the capability of trucks to haul directly from the source to the actual user destination without any transhipment on route or need for stockpiling. Some economies, if the volume of demand for silica materials are high, could reduce the given freight rates significantly. Due to the flexibility of trucks in routing and for hauling a variety of products, partial or entire

TABLE 7.1

FOR-HIRE TRUCKING COSTS FOR SILICA EXPORTS
($U.S./TONNE)

Origin \ Destination	Portland	Boston	Philadelphia	Savannah
Sussex	27.78	36.28	61.07	118.66
Saint John	23.61	33.54	58.33	115.92
Moncton (Calhoun)	31.54	40.04	64.83	122.42
Shubenacadie	43.09	51.60	76.38	133.94
Yarmouth (Chegoggin)	20.37*	28.40*	52.94*	110.53*
Aberdeen	63.78	72.29	97.08	154.67
Sydney (George R.)	68.80	77.31	102.10	159.69

* Via ferry (Yarmouth - Bar Harbour)

TABLE 7.2

FOR-HIRE TRUCKING COSTS FOR SILICA EXPORTS
(SCAN./TONNE)

Origin \ Destination	Portland	Boston	Philadelphia	Savannah
Sussex	37.50	48.98	82.44	160.19
Saint John	31.88	45.28	78.75	156.49
Moncton (Calhoun)	42.58	54.06	87.52	165.27
Shubenacadie	58.18	69.68	103.12	180.87
Yarmouth (Chegoggin)	27.50*	38.34*	71.47*	149.22*
Aberdeen	85.17	96.66	130.12	207.87
Sydney (George R.)	90.19	101.68	135.14	212.89

* Via ferry (Yarmouth - Bar Harbour)

backhauls may be available, which could also reduce the trucking freight rates. However, no potential backhauls which could use the ascribed trucks have been identified.

7.2.3 Silica Transportation by Rail Mode

Rail freight transport rates have been acquired for 90 tonne per carload (minimum load of 86 tonnes per carload) shipments of silica materials. Rail shipments are assumed to be on a single-unit or a multi-unit carload basis (i.e., not by dedicated unit train service, but pick-up of one or several cars at one time by regular rail freight line services). All silica deposits have rail lines in their vicinity but may require either for-hire trucking services to an existing rail siding or construction of a rail siding, and perhaps even a minor rail spur to properly connect to rail services. Covered hopper rail cars unload by dumping from the bottom of the cars, and this may sometimes require "shakers" to unload, if the silica has a moisture content such that it does not easily spill out of the cars. No available backhaul commodities were known at present by the rail officials.

Due to the complexity of estimating rail freight rates for transborder movements, which require revenue-sharing with U.S. railways, only silica movements from Shubenacadie and Moncton (Nixon/Calhoun) to Boston and Houston were acquired for this analysis. "Ballpark" rail transport costs for hauling silica materials to the eastern and southeastern United States market centres from the various silica deposits located in Nova Scotia and New Brunswick are estimated from these origin-destination pairs' transport costs and given in Table 7.3 in $U.S. per tonne and Table 7.4 in $Can. per tonne. Rail transport costs range from a low of $49.76 U.S. per tonne from Moncton (Calhoun) to

TABLE 7.3

RAIL TRANSPORT COSTS FOR SILICA EXPORTS
($U.S./TONNE)

Origin	Destination	
	Boston	Houston
Shubenacadie	40.84	69.56
Moncton (Calhoun)	36.86	66.00
Mulgrave (Aberdeen)	41.41	70.12
Sydney (George R.)	41.97	70.67
Sussex	36.91	66.11
Saint John	36.91	66.11

Note: Truck haulage costs per tonne to rail loading facilities, if required, are estimated as follows:

5 km = $0.94 U.S.; 10 km = $1.37 U.S.,
15 km = $1.81 U.S.; 20 km = $2.25 U.S.;
25 km = $2.72 U.S.; 30 km = $3.13 U.S.

which would be in addition to these rail transport costs.

TABLE 7.4

RAIL TRANSPORT COSTS FOR SILICA EXPORTS
($CAN./TONNE)

Origin	Destination	
	Boston	Houston
Shubenacadie	55.14	93.90
Moncton (Calhoun)	49.76	89.10
Mulgrave (Aberdeen)	55.90	94.66
Sydney (George R.)	56.66	95.42
Sussex	49.83	89.25
Saint John	49.83	89.25

Note: Truck haulage costs per tonne to rail loading facilities, if required, are estimated as follows:

5 km = $1.27 Can.; 10 km = $1.85 Can.;
15 km = $2.44 Can.; 20 km = $3.04 Can.;
25 km = $3.67 Can.; 30 km = $4.23 Can.

which would be in addition to these rail transport costs.

Boston to a high of $95.42 U.S. per tonne from Sydney to Houston. Intermediate destinations in the United States would incur transport costs within that range. Additional costs of trucking silica to existing rail loading facilities or construction costs of a new rail loading facility, if required, would be additional to these rail transport costs.

7.2.4 Silica Transportation by Marine Mode

Marine ship freight rates are presented on a per tonne basis for movements from ports located in Nova Scotia and New Brunswick to eastern and southeastern United States ports. The ships recommended for use by the steamship brokers and operators were 35 000 or 40 000 tonne self-unloading bulk carrier vessels. Rates are given for loaded vessels and include unloading and other associated harbour charges. Note that only those ports capable of handling bulk freight self-unloading carrier vessels with loading and unloading facilities available have been considered in this analysis. This information was available from the Canadian Ports and Seaway Directory and the Fairplay World Ports Directory, published annually. Ports located at Liverpool, N.S., and Newcastle (Miramichi), N.B., have insufficient depths to permit maximum draft required for full loads, and therefore their respective rates per tonne have been adjusted accordingly.

Potential backhauls are presently limited to the phosphate transported northward from the U.S. on returning gypsum ships. Other potential for backhauls is being investigated, and if available, could reduce the marine freight rates given below significantly. For instance, proposed transport of coal from Louisiana to New Brunswick might provide a backhaul for silica; however, the silica ships would be competing for the backhaul with vessel owners hauling gypsum, potash and salt.

Actual marine mode transport costs of silica are constituted of three components: a truck (or rail) haul to the port from the silica deposits, the costs of loading and handling (i.e., stockpiling and storage) at the originating port, and the actual marine vessel freight rate charges, which includes unloading at the destination ports. These components of the intermodal (truck-to-marine) transport system costs are given individually and collectively in this section.

Tables 7.5 and 7.6 give the trucking costs of hauling from New Brunswick and Nova Scotia silica deposits, respectively, to nearby Maritime ports, in $U.S. and $Can. A regular service, as may be expected with silica transport, is apt to reduce these trucking costs.

Loading and handling costs at the originating ports are composed of throughput charges, tonnage assessment charges, wharfage charges, stevedoring charges, stockpiling loader/operator charges, stockpile space rental and the amortized costs or rental of a silica transit shed. These costs have been estimated to be $3.12 U.S. per tonne and $4.21 Can. per tonne for an annual throughput of 250 000 tonnes. Port charges (throughput, tonnage assessment and wharfage charges) comprise 20.7 percent, stockpiling costs 14.0 percent, and loading/stevedoring 65.3 percent of the total loading and handling costs at the port.

Tables 7.7 and 7.8 provide the marine freight costs in $U.S. and $Can., respectively, of transporting silica from New Brunswick and Nova Scotia ports to several eastern and southeastern United States ports located in potential export markets for silica. Due to the complexity and time required to determine marine freight rates, actual rates were acquired from the steamship brokers and companies for originating ports of Mulgrave, Saint John and Belledune to destination ports of Philadelphia,

TABLE 7.5

FOR-HIRE TRUCKING COSTS FROM
SILICA DEPOSITS TO PORTS - N.B.

Silica Deposits	Port	Transport Cost $U.S./tonne	Transport Cost $Can./tonne
Sussex	Saint John	4.44	6.00
Bass River	Belledune	3.82	5.16
West Beach/ Cape Spencer	Saint John	2.25	3.04
Burchill Road	Saint John	1.56	2.10
Whitehead Island	Saint John	8.04*	10.85*
Drury Cove	Saint John	1.29	1.74
Nixon/Calhoun	Newcastle	8.35	11.27
	Saint John	9.59	12.95

*excluding ferry toll for Grand Manan Island Ferry

TABLE 7.6

FOR-HIRE TRUCKING COSTS FROM
SILICA DEPOSITS TO PORTS - N.S.

Silica Deposits	Port	Transport Cost	
		$U.S./tonne	$Can./tonne
Shubenacadie	Saint John	4.61	6.22
Elmsvale/Pembroke	Halifax	6.59	8.90
Chegoggin	Liverpool	9.50	12.83
Leitches Creek/ George R.	Sydney	2.25	3.04
Aberdeen/Skye Mtn.	Mulgrave	5.41	7.31

TABLE 7.7

MARINE FREIGHT COSTS FOR EXPORTING SILICA
(ORIGINATING TO DESTINATION PORTS IN $U.S./TONNE)

Origin \ Destination	Portland	Boston	Philadelphia	Baltimore	Savannah	Miami	Houston
Saint John	2.79	2.96	3.70	4.50	5.25	5.72	8.50
Newcastle	5.18	5.38	6.45	7.26	8.32	8.72	12.21
Belledune	4.45	4.61	5.65	6.16	7.50	7.68	10.20
Sydney	3.56	3.73	4.61	5.28	6.16	6.49	9.37
Mulgrave	3.34	3.51	4.30	5.06	6.00	6.27	9.00
Halifax	3.01	3.18	4.06	4.72	5.61	5.94	8.82
Liverpool	3.28	3.46	4.49	5.24	6.26	6.64	9.95

TABLE 7.8

MARINE FREIGHT COSTS FOR EXPORTING SILICA
(ORIGINATING TO DESTINATION PORTS IN $CAN./TONNE)

Origin \ Destination	Portland	Boston	Philadelphia	Baltimore	Savannah	Miami	Houston
Saint John	3.77	4.00	5.18	6.08	7.28	7.72	11.60
Newcastle	6.99	7.27	8.71	9.80	11.24	11.77	16.48
Belledune	6.01	6.22	7.43	8.32	9.52	9.96	13.84
Sydney	4.81	5.04	6.22	7.13	8.32	8.76	12.65
Mulgrave	4.59	4.74	5.93	6.83	8.02	8.46	12.35
Halifax	4.06	4.29	5.48	6.37	7.57	8.02	11.91
Liverpool	4.43	4.67	6.06	7.08	8.44	8.96	13.43

Savannah and Houston. Freight rates for the remaining origin-destination pairs have been estimated for this analysis. These marine freight rates range from a low of $2.79 U.S. per tonne from Saint John to Portland, Maine to a high of $12.21 U.S. per tonne from Newcastle to Houston. All rates include unloading and harbour charges at the destination ports.

Tables 7.9 and 7.10 show the composite intermodal (truck-marine) costs in $U.S. and $Can. of exporting silica from the sources in Nova Scotia and New Brunswick to the American ports. Total transport costs of moving silica by ship to prospective markets in the United States range from the lows of $7.20 U.S. and $7.47 U.S. per tonne from Drury Cove and Burchill Road silica deposits in the Saint John area to Portland, Maine, to a high of $22.57 U.S. per tonne from Chegoggin, N. S. near Yarmouth, to Houston. Relative marine transport costs are greatly affected by the proximity of the silica deposits to a bulk handling port facility due to the considerable trucking cost component.

At present, potash is hauled by a rail bulk freight unit train system on a dedicated track from Sussex to the Port of Saint John for export. CN Rail officials have estimated a representative rate of hauling silica on this system to be $3.98 U.S. per tonne or $5.37 Can. per tonne. This would provide an intermodal (rail-marine) transport system for silica from Sussex to the American destination ports. Total transport costs given in Tables 7.9 and 7.10 would be accordingly reduced for Sussex by $0.47 U.S. per tonne and $0.63 Can. per tonne.

At present, international marine shipping rates are depressed due to market conditions, creating excess capacity available in the steamship industry. However, steamship brokers advised that normal freight rates be used if this feasibility analysis as current depressed freight rates are not expected to persist, particularly for the relatively scarce supply of bulk self-unloading vessels.

TABLE 7.9

INTERMODAL (TRUCK-MARINE) TRANSPORTATION AND HANDLING COSTS OF SILICA TO U.S. PORTS ($U.S./TONNE)

Origin \ Destination	Portland	Boston	Philadelphia	Baltimore	Savannah	Miami	Houston
Sussex	10.35	10.52	11.26	12.06	12.81	13.28	16.06
Bass River	11.39	11.55	12.59	13.10	14.44	14.62	17.14
West Beach/ Cape Spencer	8.16	8.27	9.07	9.87	10.62	11.09	13.87
Burchill Rd.	7.47	7.64	8.38	9.18	9.93	10.40	13.18
Whitehead Island	13.95	14.06	14.86	15.66	16.41	16.88	19.66
Drury Cove	7.20	7.37	8.11	8.91	9.66	10.13	12.91
Nixon/Calhoun	15.50	15.67	16.41	17.26	17.96	18.43	21.21
Shubenacadie	10.74	10.91	11.79	12.45	13.34	13.67	16.55
Elmsvale/Pembroke	12.72	12.89	13.77	14.43	15.32	15.65	18.53
Chegoggin	15.90	16.08	17.11	17.86	18.88	19.26	22.57
Leitches Creek/ George R.	8.93	9.10	9.98	10.65	11.53	11.86	14.74
Aberdeen/Skye Mtn.	11.87	12.04	12.83	13.59	14.53	14.80	17.53

TABLE 7.10

INTERMODAL (TRUCK-MARINE) TRANSPORTATION AND HANDLING COSTS OF SILICA TO U.S. PORTS ($CAN./TONNE)

Origin \ Destination	Portland	Boston	Philadelphia	Baltimore	Savannah	Miami	Houston
Sussex	13.98	14.21	15.39	16.29	17.49	17.93	21.81
Bass River	15.38	15.59	16.80	17.69	18.89	19.33	23.21
West Beach/ Cape Spencer	11.02	11.25	12.43	13.33	14.53	14.97	18.85
Burchill Rd.	10.08	10.31	11.49	12.39	13.59	14.03	17.91
Whitehead Island	18.83	19.06	20.24	21.14	22.34	22.78	26.66
Drury Cove	9.72	9.95	11.13	12.03	13.23	13.67	17.55
Nixon/Calhoun	17.57	17.80	18.98	19.88	21.08	21.52	25.40
Shubenacadie	14.49	14.72	15.91	16.80	18.00	18.45	22.34
Elmsvale/Pembroke	17.17	17.40	18.59	19.48	20.68	21.13	25.02
Chegoggin	21.47	21.71	23.10	24.12	25.48	25.94	30.47
Laitches Creek/ George R.	12.06	12.29	13.47	14.38	15.57	16.01	19.90
Aberdeen/Skye Mtn.	16.11	16.26	17.45	18.35	19.54	19.98	23.87

7.3 Silica Transportation to Domestic Markets

7.3.1 Introduction

In this section, the transport costs of silica materials from the major sources in Nova Scotia and New Brunswick to prospective major market centres of central Canada (Quebec and eastern Ontario), have been tabulated. The following subsections report the carrier means and transport costs for each of the three available transport modes: trucking, rail and marine. Freight rates were attained from the same sources as ascribed in Section 7.2.1 above. All domestic freight transport costs are given in $Can. only. No backhaul opportunities were known at present by the carriers.

7.3.2 Silica Transportation by Trucking Mode

As was the case with trucking silica to foreign markets, silica hauled to domestic market centres would be transported in covered 35-tonne tandem triaxle trucks. In this case, calculation of the transport cost of movements from Chegoggin, Nova Scotia includes use of the Digby to Saint John ferry, which operates twice daily throughout the year and three times daily during the summer season, at a round trip cost of $6.33 per tonne. Table 7.11 shows the transport costs of trucking silica from locations in Nova Scotia and New Brunswick to three major prospective domestic markets of Quebec City, Montreal and Toronto. The trucking costs of silica range from a low of $45.22 per tonne from the silica deposits in the Saint John area to Quebec City, to a high of $145.33 per tonne from the Leitches Creek/George River deposit near Sydney to Hamilton.

TABLE 7.11

FOR-HIRE TRUCKING COSTS FOR SILICA
TO DOMESTIC MARKETS ($CAN./TONNE)

Origin \ Destination	Quebec	Montreal	Toronto	Hamilton
Sussex	47.06	63.10	98.68	102.88
Saint John	45.22	61.26	96.90	101.10
Moncton (Calhoun)	52.61	68.38	102.31	106.51
Shubenacadie	68.21	86.03	121.60	125.80
Yarmouth (Chegoggin)	58.70*	76.53*	110.37*	114.57*
Aberdeen	84.65	100.43	134.35	138.55
Sydney (George R.)	91.43	107.21	141.13	145.33

* Via ferry (Digby - Saint John)

7.3.3 Silica Transportation by Rail Mode

Silica materials transported by rail are contained in 90-tonne carloads using closed-top hopper cars. Due to the anticipated volumes of traffic of silica at or below 250 000 tonnes per year to dispersed markets interspersed throughout the year, potential for setup of a dedicated unit train service is unlikely. Freight rates have, therefore, been presented on a single carload basis for this analysis. Construction of on-site loading facilities may be required, if not already available, to gain long-run efficiencies over use of trucks for transporting from the silica deposits to existing remote loading facilities. Rail car "shakers" may be required at the unloading facilities at the market destinations, if moisture content poses problems in unloading.

Table 7.12 gives the rail transport costs of hauling silica to domestic market centres--Montreal and Toronto from Moncton (Calhoun), Shubenacadie, Mulgrave (Aberdeen) and Sydney (Leitches Creek/George River) silica deposits. Rail transport costs to domestic markets range from a low of $18.43 per tonne for Moncton (Calhoun) to Montreal movement to a high of $34.44 per tonne for Sydney to Toronto. Saint John and Sussex rates were estimated for this analysis.

7.3.4 Silica Transportation by Marine Mode

Silica materials transported by marine mode to domestic markets would be contained in 35 000 tonne self-unloading bulk carrier vessels. Silica ships destined for Toronto would be restricted to approximately 25 000 tonne maximum loads in order to operate within the 26-foot maximum draft available in the St. Lawrence Seaway. Therefore, freight rates to Toronto or elsewhere within the St. Lawrence Seaway are proportionally higher. The relatively short supply of self-unloaders in Canada at present (34

TABLE 7.12

DOMESTIC RAIL FREIGHT COSTS FOR SILICA ($CAN./TONNE)

Origin	Destination	
	Montreal	Toronto
Sussex	18.50	29.00
Saint John	18.50	29.00
Moncton (Calhoun)	18.43	28.85
Shubenacadie	23.14	32.40
Mulgrave (Aberdeen)	23.90	33.42
Sydney (George R.)	24.66	34.44

Note: Truck haulage costs per tonne, if required, to rail loading facilities are:

5 km = $1.27; 10 km = $1.85; 15 km = $2.44
20 km = $3.04; 25 km = $3.67; 30 km = $4.23

which would be in addition to these rail freight costs.

in total) are occupied such that only nine vessels would be available to service Belledune, Mulgrave and Halifax, and of those, only seven to Saint John. Silica would be in competition with gypsum, potash, coal and salt for these vessels, which move from the Maritimes into Quebec and Ontario markets. It, therefore, is very unlikely that current depressed rates will persist for long into the future. No potential backhaul opportunities are available at present.

Silica transported by marine mode to domestic markets would involve three component costs: trucking costs from silica deposits to originating ports, loading and handling costs, and marine freight costs from originating to destination ports, including unloading at the destination ports.

Table 7.5 and Table 7.6 of Section 7.2.4 gave the trucking costs from the silica deposits in New Brunswick and Nova Scotia, respectively, to their adjacent ports. These rates are applicable to movements to the domestic silica markets, as well. Loading and handling charges were given to be $4.21 Can. per tonne in Section 7.2.4, which also applies to the domestic movements.

Table 7.13 provides the domestic marine freight costs for transporting silica from originating ports to the destination ports, including harbour and unloading charges at the destination ports. Marine freight rates were obtained for silica movements originating in Belledune, Mulgrave, Halifax and Saint John to Quebec City, Montreal and Toronto. Other origin-destination pairs have been estimated for this analysis. Newcastle and Liverpool rates reflect the additional costs of operating to Quebec and Montreal with less than a full load due to draft capacity limitations. Marine freight costs range from a low of $4.25 per tonne from Belledune to Quebec City, to a high of $10.45 per tonne from Saint John to Toronto.

TABLE 7.13

DOMESTIC MARINE FREIGHT COSTS FOR SILICA
FROM ORIGINATING TO DESTINATION PORTS ($CAN./TONNE)

Origin	Destination		
	Quebec	Montreal	Toronto
Saint John	6.55	7.30	10.45
Newcastle	5.15	6.05	9.45
Belledune	4.25	5.00	8.15
Sydney	4.32	5.07	8.22
Mulgrave	4.30	5.05	8.20
Halifax	4.35	5.10	8.25
Liverpool	5.04	5.90	9.22

Table 7.14 gives the composite transport costs of the intermodal (truck-to-marine) system for domestic movements of silica from New Brunswick and Nova Scotia silica deposits to Quebec and Ontario market centres. Marine transport costs range from a low of $11.57 per tonne from the Leitches Creek/George River area near Sydney to Quebec City to a high of $26.22 per tonne from Chegoggin near Yarmouth to Toronto. As was the case in Section 7.2.4, silica deposits in Sussex can be served by unit train to the port of Saint John at a cost of $5.37 per tonne, which would accordingly reduce rates in Table 7.14 from Sussex by $0.63 per tonne.

TABLE 7.14

INTERMODAL (TRUCK-MARINE) TRANSPORTATION AND HANDLING COSTS OF SILICA TO DOMESTIC PORTS ($CAN./TONNE)

Origin	Destination		
	Quebec City	Montreal	Toronto
Sussex	16.76	17.51	20.66
Bass River	13.62	14.37	17.52
West Beach/Cape Spenser	13.80	14.55	17.70
Burchill Rd.	12.86	13.61	16.76
Whitehead Island	21.61	22.36	25.51
Drury Cove	12.50	13.25	16.40
Nixon/Calhoun	20.63	21.53	24.93
Shubenacadie	14.78	15.53	18.68
Elmsvale/Pembroke	17.46	18.21	21.36
Chegoggin	22.08	22.94	26.22
Leitches Creek/George R.	11.57	12.32	15.47
Aberdeen/Skye Mtn.	15.82	16.57	19.77

8. MARKET EVALUATION

8.1 Introduction

There are many important market variables which cannot be controlled by a producer. They include competition, demand, legal and political actions, technological changes, and public opinion.

Although uncontrollable, these factors can be anticipated and their effects reduced. Thus, it is important that a Nova Scotia or New Brunswick producer become informed and remain current about developments in uncontrollable market variables.

8.2 Competition - Identity, Size and Location

8.2.1 United States

Presented in Table 8.1 are details of the largest silica sand producers in the United States, including name, size, head office location, number of pits, pit size, pit location, and the presence, if any, of a processing plant.

Like many industrial minerals such as clays and limestone, silica is widely distributed with deposits found in most states. However, as for clay and limestone, silica tends to be mined in only a few areas where the quantity and quality of material in the deposit can support one or more large operation. Thus, any New Brunswick or Nova Scotia silica producer would find that his competition would be located in a few centres.

As shown in Tables 8.2 and 8.3, there are a few, large centres of silica production in the United States. They include New Jersey, Pennsylvania, Virginia, North Carolina, South Carolina, Georgia, Alabama, and Texas. The other fourteen states have relatively low or no production.

TABLE 8.1

CHARACTERISTICS OF PROMINENT SILICA PRODUCERS IN THE UNITED STATES (1983)

Submarket	Company			Pits			Plant
	Name	Size	Location (head office)	Number	Locations (County)	Size	
Massachusetts	Holliston Sand Co. Inc.	Very Small	Holliston	1	Middlesex	Small	No
	Whitehead Bros. Co.	Medium	Leesburg, NJ	1	Plymouth	Small	No
Rhode Island	Unknown	Very Small	-	-	-	-	-
Connecticut[1]	Ottawa Silica Co. Connecticut Div.	Very Large	Ottawa, IL	1	New London	Medium	Yes (crushed)
	Feldspar Corp.	Medium	Middletown	2	Middlesex	Small Large	U
New York	Whitehead Bros. Co.	Medium	Leesburg, NJ	1 1	Oneida Saratoga	Small Small	No No
New Jersey	Whitehead Bros. Co.	Medium	Leesburg, NJ	2	Cumberland (1 dredge)	Both Medium	No
	New Jersey Silica Sand Co.	Medium	Millville, NJ	1	Cumberland (dredge)	Large	No
	Pennsylvania Glass Sand Co. (PGS)	Very Large	Berkeley Springs, WV	1	Cumberland	Large	No
	Unimin Corp., Dividing Creek Plant	Very Large	New Canaan, CT	1	Cumberland	Medium	No
	Jessie S. Morie and Son	Large	Mauricetown	1	Cumberland	U	Yes (aggregate by-product)

1 Two companies in 1983, three in 1982.

Pit size: Small - 0 - 9 employees; Medium - 10 - 34 employees; Large - 35-99 employees; Very Large - over 99 employees; U - unknown

TABLE 8.1 (continued)

CHARACTERISTICS OF PROMINENT SILICA PRODUCERS IN THE UNITED STATES (1983)

	Company			Pits			
Submarket	Name	Size	Location (head office)	Number	Locations (County)	Size	Plant
New Jersey	Owens-Illinois	Very Large	Millville	1	Cumberland	Medium	No
Pennsylvania	McCrady Inc.	U	Pittsburgh	2	Allegheny	U	No
	Pennsylvania Glass Sand Corp. (PGS)	Very Large	Berkeley Springs, WV	2	Huntingdon	One Very Large One Unknown	No
	Glacial Sand and Gravel Co.[2]	Small	Kittaning	1	Armstrong	Medium	No
	Airport Sand and Gravel Co. Ltd.	Small	Wyoming	1	Luzerne	Medium	No
Maryland	Harford Sands Inc.	Very Small	Joppa	1	Harford	Small	No
Virginia	Unimin Corp.	Very Large	New Canaan, CT	1	Frederick	Large	Yes
	J. C. Jones Sand Co. Inc.	Very Small	Norfolk	1	Virginia Beach (dredge)	Small	Yes
	Saltville Silica[3]	U	Saltville	1	Smyth	U	No
North Carolina	Unimin Corp.	Very Large	Marston	U	U	U	Yes (silica flour)
	International Minerals and Chemical Corp.	Very Large	Des Plaines, IL	3	Mitchell	2 Small 1 Medium	Yes (as a feldspar by-product)

2 Not listed in 1983, only 1982
3 Ceased operation in 1983

TABLE 8.1 (continued)

CHARACTERISTICS OF PROMINENT SILICA PRODUCERS IN THE UNITED STATES (1983)

Submarket	Company			Pits			
	Name	Size	Location (head office)	Number	Locations (County)	Size	Plant
North Carolina	Five other companies	U	U	U	Anson-Richmond (80% total production)	U	U
				U	Cleveland	U	U
				U	Harnett	U	U
South Carolina	Pennsylvania Glass Sand Corp. (PGS)	Very Large	Berkeley Springs, WV	1	Lexington	Large	Yes (ground)
	Columbia Silica	Small	Columbia	3	Lexington	All Small	U
	Two companies	U	U	U	Lexington	U	U
				U	Kershaw	U	U
	Whitehead Bros.	Medium	Leesburg, NJ	1	Kershall	Medium	U
Georgia[4]	Crawford County Mining Inc.	Small	Roberta	1	Crawford	Medium	No
	L.C. Curtis & Son Inc.	Very Small	Watkinsville	1	Greene (dredge)	Small	No
	Jessie S. Morie and Son Inc.	Large	Millville, NJ	1	Marion	Large	No
	Montgomery Sand Co. (Florida Crushed Stone)	U	Thomasville	1	Thomas	U	No
Florida	Pompano Silica and Sand Inc.	Very Small	Pompano	1	Broward (dredge)	Small	U

4 Six companies operated in 1982

TABLE 8.1 (continued)

CHARACTERISTICS OF PROMINENT SILICA PRODUCERS IN THE UNITED STATES (1983)

Submarket	Company			Pits			
	Name	Size	Location (head office)	Number	Locations (County)	Size	Plant
Florida	Three companies	U	U	U	U	U	U
	One company	U	U	U	U	U	Yes (Kaolin by-product)
Alabama	Five companies	U	U	U	U	U	U
	Globe Metallurgical Div., Interlake Inc.	U	U	1	Antauga	U	U
Mississippi	Technical Sands Inc.	Very Small	Moss Point	1	Jackson	Small	U
	One company	U	U	U	Tishoningo	U	U
Louisiana	One company	U	U	U	Webster	U	U
	Southern Silica of Baton Rouge	Small	Alexandria	1 1	East Baton Rouge Allen (dredge)	Medium Small	U U
	Copp Industrial Corp.	Small	Coushatta	1	Red River	Small	U
Texas	Unimin Corp.	Very Large	New Canaan, CT	1	Johnson	U	Yes
	Pennsylvania Glass Sand Corp. (PGS)	Very Large	Berkeley Springs, WV	1 1	McCulloch Live Oak	Large Medium	Yes (crush) Yes
	Texas Mining Co. (Oglebay Norton Co)	Medium	Arlington	2	McCulloch	Both Medium	Yes (crush)
	Vulcan Materials	Very Large	San Antonio	1	McCullock	U	Yes

TABLE 8.1 (continued)

CHARACTERISTICS OF PROMINENT SILICA PRODUCERS IN THE UNITED STATES (1983)

	Company			Pits			
Submarket	Name	Size	Location (head office)	Number	Locations (County)	Size	Plant
Texas	NOWSCO (Big Three Industries Inc.)	Very Large	Longview	1	U	U	

TABLE 8.2

SIZE DISTRIBUTION OF SILICA SUPPLIERS IN THE UNITED STATES

Market	Submarket	Number of Suppliers, According to Company Size					
		Very Large	Large	Medium	Small	Very Small	Unknown
New England	Maine	-	-	-	-	-	-
	New Hampshire	-	-	-	-	-	-
	Vermont	-	-	-	-	-	-
	Massachusetts	-	-	1	-	1	-
	Rhode Island	-	-	-	-	1	-
	Connecticut	1	-	1	-	-	-
Middle Atlantic	New York	-	-	1	-	-	-
	New Jersey	3	1	2	-	-	-
	Pennsylvania	1	-	-	2	-	1
South Atlantic	Delaware	-	-	-	-	-	-
	Maryland	-	-	-	-	1	-
	Virginia	1	-	-	-	1	1
	North Carolina	2	-	-	-	-	3
	South Carolina	1	-	1	1	-	2
	Georgia	-	1	1	1	1	1
	Florida	-	-	-	-	1	4
Gulf of Mexico	Alabama	-	-	-	-	-	6
	Mississippi	-	-	-	-	1	1
	Louisiana	-	-	-	2	-	1
	Texas	3	-	1	-	-	-

TABLE 8.3

ANNUAL PRODUCTION OF SILICA SAND IN UNITED STATES
BY MARKET AND STATE (1982)

Market	Submarket	Production			
		Thousands of Tonnes	Percent of Total	$* (Thousands)	Percent of Total
New England	Maine	-	-	-	-
	New Hampshire	-	-	-	-
	Vermont	-	-	-	-
	Massachusetts	127	0.5	1 615	0.5
	Rhode Island	5	-	52	-
	Connecticut	73	0.3	1 746	0.5
	Subtotal	205	0.8	3 413	1.0
Middle Atlantic	New York	41	0.2	512	0.2
	New Jersey	1 945	7.5	28 151	8.6
	Pennsylvania	881	3.4	13 589	4.2
	Subtotal	2 867	11.1	42 252	13.0
South Atlantic	Delaware	-	-	-	-
	Maryland	W (likely 250(-))	W (likely 1.0(-))	W (likely 4 760(-))	W (likely 1.3(-))
	Virginia	W (likely 900(+))	W (likely 3.5(+))	W (likely 15 000(+))	W (likely 4.6(+))
	North Carolina	651	2.5	4 878	1.5
	South Carolina	654	2.5	10 902	3.4
	Georgia	492	1.9	6 793	2.1
	Florida	310	1.2	4 257	1.3
	Subtotal	3 249	12.6	45 980	14.2
Gulf of Mexico	Alabama	870	3.4	8 096	2.5
	Mississippi	35 (est.)	0.1 (est.)	516 (est.)	0.2 (est.)
	Louisiana	343	1.3	4 590	1.4
	Texas	2 000	9.2	35 974	11.1
	Subtotal	3 248	12.6	49 176	15.2
United States	Total	25 818	100.0	323 800	100.0

* 1982 American $ W = withheld

Based upon the above information, it appears that New Brunswick and Nova Scotia producers would find it difficult to penetrate the American market below New Jersey.

The analysis presented in Table 8.4 reinforces this assumption. The table presents five measures of competition: production quantity, value, and employees per capita (state population) and production quantity and value per supplier (in state). For each measure the state value is compared to the national standard. This analysis shows, on a per capita basis, that suppliers produce more, earn more, and have more employees in New Jersey, South Carolina, Alabama, and Texas. In addition, Virginia, North Carolina, and Georgia have above average values in one or two of these indices. These states are centres of silica production and likely serve as net sources, not sinks, of silica.

In terms of supplier size (measured by production quantity and value per capita), New Jersey, Pennsylvania, Maryland, Virginia, South Carolina and Texas have above average suppliers. In particular, the suppliers of New Jersey, Virginia and Texas are formidable competition, producing large volumes of silica and generating substantial cash flow. Checking the identity of these suppliers in Table 8.1 reveals that they are large mining and/or manufacturing (glass, silicon carbide) firms, well established in the market, often with operations in many states.

It would seem, therefore, that any New Brunswick or Nova Scotia producer wishing to compete in the United States should focus their efforts on the New England and New York markets.

8.2.2 Ontario and Quebec

Indusmin Limited/Limitée dominates silica production in both Ontario and Quebec. Although company figures are not available, it is estimated that Indusmin produces over 60 percent of total

TABLE 8.4

COMPETITION ANALYSIS OF AMERICAN SILICA MARKETS
(DARK FIGURES ARE VALUES OVER NATIONAL AVERAGE)

Market	Submarket	Population	Quantity, tonnes	Value, $	Employees* (x 1 000 000)	Number	Quantity, tonnes (000 000)	Value, $ (000 000)
New England	Maine	0.99	-	-	-	-	-	-
	New Hampshire	0.74	-	-	-	-	-	-
	Vermont	0.44	-	-	-	-	-	-
	Massachusetts	5.69	0.022	0.28	0.18	2	0.069	0.81
	Rhode Island	0.95	0.001	0.06	0.52	1	0.005	0.05
	Connecticut	3.03	0.022	0.58	1.32	2	0.037	0.87
	Subtotal	11.84	0.017	0.29	0.46	5	0.041	0.68
Middle Atlantic	New York	18.19	0.002	0.03	0.05	1	0.041	0.51
	New Jersey	7.17	**0.271**	**3.93**	**3.54**	7	**0.278**	**4.02**
	Pennsylvania	11.79	0.075	1.15	1.60	4	**0.220**	**3.40**
	Subtotal	37.15	0.077	1.14	1.35	12	**0.260**	**3.52**
South Atlantic	Delaware	0.55	-	-	-	-	-	-
	Maryland	3.92	0.064*	1.06*	0.13	1	**0.250**	**4.16**
	Virginia	4.65	0.194*	**3.23***	1.66	3	**0.300**	**5.00**
	North Carolina	5.08	**0.128**	0.96	**2.95**	7	0.093	0.70
	South Carolina	2.59	**0.253**	**4.21**	**3.86**	5	**0.164**	**2.18**
	Georgia	4.59	0.107	1.48	**2.85**	4	0.123	1.70
	Florida	6.79	0.046	0.63	1.47	5	0.062	1.06
	Subtotal	28.17	0.115	1.63	2.34	25	0.135	1.84
Gulf of Mexico	Alabama	3.44	**0.253**	**2.35**	**3.49**	6	0.145	1.35
	Mississippi	2.22	0.016	0.23*	0.45	2	0.018	0.26
	Louisiana	3.64	0.094	1.26	1.37	3	0.114	1.53
	Texas	11.20	**0.213**	3.21	2.23	4	**0.500**	**8.99**
	Subtotal	20.50	**0.177**	**2.40**	**2.09**	15	**0.216**	**3.28**
United States		216.45	0.119	1.50	1.98	162	0.159	2.00

* estimate

production in Quebec and Ontario. All other producers are much smaller in size and would represent smaller competition to a New Brunswick or Nova Scotia supplier in the Ontario and Quebec Markets (Tables 8.5 and 8.6).

Table 8.7 shows that Indusmin is a large producer even by American standards. Not shown in that table, however, are the several American firms which export silica to Canada. Over 1.0 M tonnes of silica is imported by Canada every year, most of it to Ontario, much of it from Michigan and Illinois. Thus, although the Ontario and Quebec markets are dominated by one domestic firm, there is already a substantial demand fulfilled by sand produced outside Ontario and Quebec. However, these American exporters appear to be large (e.g., Ottawa Silica) firms which could provide formidable competition to a Nova Scotia or New Brunswick producer.

8.3 Financial Analysis of Industry

8.3.1 United States

Every industry has an identifiable pattern of costs and investment caused by the similarity of inputs and assets required for production. By analyzing this pattern, a New Brunswick or Nova Scotia producer can compare the financial pattern of suppliers in a target market to his own and uncover insights into the strengths and weaknesses of the competition and himself. For example, he may discover that the competition has a higher proportion of their assets tied into machinery or equipment or have a larger proportionate labour cost. Either of these factors could reduce the ability of competitors to lower their prices.

Table 8.9 presents several important financial values for industrial sand and gravel producers in the United States. Here are several notable highlights of the industry pattern:

TABLE 8.5

CHARACTERISTICS OF PROMINENT SILICA PRODUCERS IN ONTARIO AND QUEBEC

Market	Name	Size	Location (Head Office)	Number	Locations	Size
Quebec	Armand Sicotte et Fils Ltée (Howick)	Small	St. Hubert	1	Howick	Medium
	Electro-Metallorgie (SKW Canada Limitée)	Small	Montréal	1	Montréal	Medium
	Indusmin Limited/ Limitée	Very Large	St. Jerome	1	St. Jerome	Very Large (est.)
	Les Mines de Silice Montréal Ltée	Very Small	Montréal	1	Montréal	Small
	Mines Lorna Lily Inc.	Very Small	Montréal	1	Montréal	Small
	Societé Minière Melocheville Limitée (Melocheville Quartzite)	Very Small	Montréal	1	Melocheville	Small

Company Size: Very Small - 0 - 9 employees
Small - 10 - 49 employees
Medium - 50 - 99 employees
Large - 100 - 199 employees
Very Large - over 200 employees

TABLE 8.5 (continued)

CHARACTERISTICS OF PROMINENT SILICA PRODUCERS IN ONTARIO AND QUEBEC

Market	Name	Size	Location (Head Office)	Number	Locations	Size
Ontario	Indusmin Limited/ Limitée	Very Large	Toronto	1	U	Very Large
				1	U	Very Large
	International Minerals and Chemical Corporation of Canada Ltd.	Medium	Havelock	1	Blue Mountain	Large

Pit size: Small - 0 - 9 employees
Medium - 10 - 49 employees
Large - 50 - 99 employees
Very Large - over 100 employees

TABLE 8.6

SIZE DISTRIBUTION OF SILICA SUPPLIERS
IN ONTARIO AND QUEBEC

Market	Number of Suppliers and Size					
	Very Large	Large	Medium	Small	Very Small	Unknown
Quebec	1	-	-	2	3	-
Ontario	1	-	1	-	-	-

TABLE 8.7

COMPETITION ANALYSIS OF ONTARIO AND QUEBEC MARKETS

Market	Population (millions)	Per Capita			Per Supplier		
		Quantity, tonnes	Value, $	Employees* (x 1 000 000)	Number	Quantity, tonnes (000 000)	Value, $ (000 000)
Quebec	5.8	0.114	2.19	3.44	6 Indusmin alone	0.11 0.40*	2.1 7.6*
Ontario	6.9	0.063	1.20	5.43	2 Indusmin alone	0.24 0.35*	4.2 6.6*
Canada	22.8	0.075	1.40	3.07	11	0.16	2.9
United States	216.5	0.115	1.99**	1.98	162	0.15	2.0**

* Estimated

** In Canadian dollars = $0.75 American

TABLE 8.8

FINANCIAL STATUS OF INDUSTRIAL SAND AND GRAVEL PRODUCERS
IN THE UNITED STATES, 1982
(1982 CENSUS OF MINERAL INDUSTRIES)

Item	United States Value, $M	%	New Jersey Value, $M	%	Texas Value, $M	%
Value of shipments	341.9	100.0	36.0	100.0	31.7	100.0
Value added in mining	223.5	65.4	20.8	57.8	18.7	59.0
Expenses:						
- payroll, all employees	83.2	24.3	8.1	22.5	6.6	20.8
- supplies (incl. fuel, power, machinery, minerals and other)	159.3	46.6	18.4	51.1	15.5	48.9
Gross book value of depreciable assets	495.8	100.0	68.2	100.0	36.9	100.0
- buildings and other	55.0	11.1	4.9	7.2	2.3	6.2
- machinery, equipment	410.7	82.8	63.1	92.5	33.0	89.4
- mineral exploration	9.2	1.9	-	-	0.1	0.3
- mineral land and rights	21.0	4.2	0.2	0.3	1.5	4.1
Capital Expenditures:	40.9	8.2 of assets	3.3	4.8	2.4	6.5
		100.0 of expenditures		100.0		100.0
- mineral exploration and development	0.4	0.8	-	-	-	-
- new building and equipment	39.3	96.1	3.2	97.0	2.0	83.3
- used building and equipment	1.2	2.9	-	-	0.4	16.7
Ratio of shipment value to depreciable assets	0.69		0.53		0.86	

As a percentage of "shipment value" in 1982
- "value added in mining" ranged from 57.8 to 65.4
- "payroll expense" ranged from 20.8 to 24.3
- "supplies expense" ranged from 46.6 to 51.1

As a percentage of "gross book value"
- "buildings and other" ranged from 6.2 to 11.1
- "machinery, equipment" ranged from 82.8 to 92.5
- "mineral exploration" ranged from 0.0 to 1.9
- "mineral land and rights" ranged from 0.3 to 4.2
- "capital expenditures" ranged from 4.8 to 8.2

As a percentage of "capital expenditures"
- "mineral exploration and development" ranged from 0.0 to 0.8
- "new building and equipment" ranged from 83.3 to 97.0
- "used building and equipment" ranged from 0.0 to 16.7

8.3.2 Quebec and Ontario

Unfortunately, financial information on Canadian silica producers is not available. Statistics Canada lumps silica together with barite, gemstones, salt, pyrite, sulphur, etc., under the heading of "other non-metal mines" in its annual publication "Non-metal Mines," thus making it impossible to determine costs and assets.

8.4 Tariffs and Other Legal Fees

Imports to the United States:

Number: 513-11

Description: Silica containing 95 percent or more silica and not more than 0.6 percent iron oxide

Schedule: Most favoured nation (MFN):
$0.03/long ton (January 1, 1986)
free (January 1, 1987)

Non-MFN:
$2.00/long ton

Imports to Canada: free

(Source: Energy, Mines and Resources, Canada and U.S. Bureau of Mines)

Australia supplies 80 percent of silica imports to the United States, Canada 13 percent.

There is a 14 percent depletion allowance (domestic and foreign) on industrial sand or pebbles.

Quebec and Ontario. American imports of silica sand into Canada are free of duty.

9. LONG-TERM TRENDS IN SILICA PRODUCTION

9.1 Supply

9.1.1 Introduction

Deposits of good quality silica which are large, easily accessible and easily worked are not common. Thus, suppliers often supply silica to a large market area. With the silica supply concentrated to a few large suppliers and a few large pits, any trends which could affect supply could have a substantial effect on the entire silica market.

Presented below are a number of trends which could affect silica supply.

9.1.2 Land Use Conflicts

There is an increasing occurrence of land use conflicts among real estate developments, farms, watersheds (surface and ground water supplies), parks, and mines. The conflict is particularly acute in the densely populated strip of land running from Portland, Maine through to Norfolk, Virginia. This strip includes eastern Massachusetts (Boston), Rhode Island, Connecticut, southern New York (New York City), northern New Jersey, southeastern Pennsylvania (Philadelphia), Delaware, eastern Maryland (Baltimore), Washington, D.C., and eastern Virginia. This is the area of the United States with the greatest potential for market penetration. Another location with conflicts is southern Florida.

When land use conflicts occur, mining usually receives a low priority, especially for a low value commodity such as silica. Examples:

- There have been no new rock quarries in Delaware since 1968. More and more silica and aggregate is imported, as it has become increasingly difficult to expand or develop the state's silica and aggregate resources. The proportion of imported to domestically produced material is not known. (ref. 9.1).

- Several Maryland operators have faced protests from nearby residents. Complaints have included property damage from blasting, proximity of pits and quarries to residences, and increased truck traffic (ref. 9.2).

- Crushed stone operators in Loudown and Roanoke Counties, Virginia have had expansion plans opposed by residents (ref. 9.3).

- The Readington Township Committee in Hunterdon County, New Jersey, voted unanimously (1983) for a three-year moratorium on mineral exploration, drilling and extraction. A land purchase by a producer in nearby West Amwell Township generated considerable opposition (ref. 9.4).

- Pennsylvania operators faced opposition in Cumberland and Berks Counties (ref. 9.5).

- National and state parks in Pennsylvania, Maryland, and North Carolina were expanded recently, removing large areas of land from potential production (ref. 9.6, 9.7, 9.8).

- Similar conflicts have occurred in Ontario and Quebec. An example is the controversy regarding the operation of quarries on Montreal Island.

Land use conflicts will continue to increase as urban areas grow. The Maritimes will not be immune to these conflicts but should experience them to a lesser degree because these provinces are not heavily populated. Thus, this trend enhances the market potential for New Brunswick and Nova Scotia silica producers, as it tends to reduce the number of developable deposits and make them more distant, and more expensive to develop.

9.1.3 New Deposits

As mentioned earlier, silica production is concentrated to a relatively few producers and reserves. Therefore, any large new silica source could have a pronounced effect upon the entire industry.

One example of such a source is the Magdalen Islands. There reserves of at least 100 million tonnes of silica are available from offshore, underwater deposits. The sand assays a silica content of 88 percent with 10 percent potassium feldspar. Studies prepared for the claim holder, Magdalen Silica Inc., have shown "a very viable market for the product." Feldspar would be sold as a by-product.

The silica would be "mined" using dredges and taken to Gaspe Bay for processing. The operation would be large, requiring a capital investment of $10-15 M and employing 100 persons (ref. 9.9).

Development of reserves of this size would have a negative effect on Maritime producers because the Maritime producer would be competing against a large-scale producer in his own "back yard." The Maritime producer would then have to compete on the basis of a superior quality of silica.

9.1.4 Safety and Health

In the 1980-83 period, 300 deaths and 47 000 nonfatal injuries occurred in the mining industry in the United States. The United States Mine Safety and Health Administration (MSHA) is trying to reduce these figures and is proposing regulations to increase mine safety. Several of the proposed regulations would affect silica producers including: revisions to loading, hauling and dumping regulations, brake testing for all vehicles capable of traveling faster than 16 km/h, and reinforcement of cab roofs on front-end loaders and bulldozers. All these changes would increase operations costs and improve the cost relationship for Maritime producers (ref. 9.10).

In a Canadian context, Ontario and Quebec governments often follow the lead of the Americans, so the effect would be similar.*

9.1.5 Environmental Legislation

Several new environmental regulations could affect American mining firms. Underground fuel storage tanks have become a predominant concern of the Environmental Protection Agency (EPA). Now only "tanks made of noncorrosive material, cathodically protected steel clad with a noncorrosive material, or designed to prevent releases of stored substances" will be accepted. Owners of existing tanks will have to report them to state officials. In 1987, rules on tank testing and replacement will be released.

It is estimated that new tanks cost between $5.00 to $8.00 per litre and tank repair, $2.00 per litre--an additional cost of doing business (ref. 9.11).

Reduction of the maximum permissible blast vibration levels by an increasing number of agencies is supported by recent U.S. Bureau of Mines technical publications. Pennsylvania was the first state to adopt the 2.0 inclus per second peak particle velocity criterion as a safe standard in 1957 but in 1974 was forced to adopt stricter controls because of citizen pressure and lawsuits involving both annoyance and alleged damaged to residences (ref. 9.12).

The EPA in 1980 released new regulations regarding dust control from crushers, bucket elevators, and grinders. Wet suppression systems are permitted.

A new EPA handbook will downplay the impact on communities from aggregate dust. This should make pit and quarry expansion easier (ref. 9.13).

These trends will raise production costs and increase market attractiveness for Maritime producers. As before, it is safe to assume that American trends would be followed to Ontario and Quebec.*

9.1.6 Environmental Constraints

The mining industry is viewed with suspicion by many environmentalists. Tailings, open pits, and destruction of wildlife habitat are among the key issues in the debate between economic progress and environmental preservation. In recent years,

(*Note: Even if these measures were implemented in the Maritimes, Maritime suppliers would benefit for two reasons. First, implementation would likely cost less in the Maritimes because of lower population density. Second, as costs increase, they tend to converge (ex. $1.00 price difference is 10 percent on $10.00 but only 5 percent on $20.00). As prices converge, other factors (quality, reliability) become more important.)

mining firms, including silica producers, have had their operations curtailed for environmental reasons. An example was the limit placed on Unimin Corp.'s dune sand mining in Michigan in 1984 (ref. 9.14).

In the long-term, it appears that the environmental restrictions will increase on all silica producers. This could prove advantageous to New Brunswick and Nova Scotia exporters.

9.1.7 Reserve Depletion Tax Benefit

At present, American aggregate producers benefit from a tax benefit called "percentage depletion." It allows producers to deduct 5 percent of total income as a result of depleting their resource. The benefit is of particular importance in states where strong environmental public opinion and laws make exploration costs high. New York is one such state.

In recent years, the Democratic Party has proposed reduction or elimination of percentage depletion, the Republican Party has favoured retention or slight reduction in the benefit (ref. 9.15).

If percentage depletion were eliminated, American producers would pay much more tax and Canadian producers receive a substantial market enhancement. It should be noted, however, that Canadian operators have similar tax relief; loss of it would hurt them similarly to the loss of depletion tax credit in the United States.

9.1.8 Technological Developments

Several recent developments have the potential of improving and expanding the mining of silica:

(a) A study investigated the potential for mining and marketing offshore sand and gravel deposits off the coast of southern California. Analyses showed that a mining and processing vessel handling 1.0 M tonnes per year could be economic (ref. 9.16).

(b) Automation and computer controls are being introduced for many pit, quarry, and processing operations (ref. 9.17).

(c) Improved blasting techniques allow quarries to be operated safely in congested areas (ref. 9.18).

(d) Increased use of geophysical techniques for mapping overburden. Recent advances have reduced cost, increased speed and expanded the range of geophysical mapping (ref. 9.19)

(e) Remote-sensing. New thermal infrared imagery techniques can be used to detect free silica in areas covered by remote-sensing aircraft. These techniques could simplify the location and estimation of silica reserves and enhance the development of silica resources (ref. 9.20).

Most of these advances would help all producers expand their operations or continue to operate longer, and thus, they reduce market potential for Maritime producers.

9.2 Demand

9.2.1 Introduction

On the demand side, the silica market is concentrated into a few industries (glass, silicon carbide, foundries) and is, therefore, quite vulnerable to developments in these industries. Presented below are trends in glass-consuming industries.

9.2.2 Construction Products

The construction industry is a major consumer of silicon through such products as flat glass, fiberglass, roofing granules and fillers, ceramics (brick, tile), filters (putty, paint), decorative gravel and chemicals. For the most part, the markets for these products should remain constant and might even expand. These markets will remain cyclical, however, because they are dependent upon the cyclical construction market.

Of more promise to silica producers are new products or applications which will use substantial quantities of silica. One American firm has developed a new glass fibre fabric called Fibrecoat. Coated with a blend of ceramic and binder, the material is resistant to flame, high temperatures, water, steam, ice, ultraviolet radiation, solvents, dilute acid, and dilute alkali. The material is intended to compete with glass fibres, mineral wool, and asbestos (ref. 9.21).

New products which use silica will increase demand and improve the market for all suppliers, including those in the Maritimes (U.S. Bureau of Mines).

9.2.3 Decline in Glass Container Use

The American domestic glass container industry is in a period of decline. Shipments were down 12.5 percent in 1984 compared to 1980. Plastic, aluminum and imported glass (Mexico) containers have captured market share from the domestic producers. As well, many jurisdictions have controlled the use of nonreturnable bottles and encouraged recycling.

In response to the drop in demand, glass container producers have reduced production, consolidated operations, and reduced prices. Since 1980, twenty plants have been closed, leaving about 100 in all. Ten of the closures occurred in 1984; in the 1981-82 period along, Owens-Illinois reduced its work force by 15 000, a 20 percent drop (see Table 9.1).

At present, 4 firms control about 75 percent of the glass container market; they are (in order): Owens-Illinios, Brockway, Anchor Glass, and Container General (see Table 9.2). In the mid-1970s, there were 20 glass container producers; now there are only 12, thanks to mergers, buyouts, and closures.

In 1984 the Glass Packaging Institute petitioned the US Trade Representative to investigate subsidized glass imports from Mexico.

The situation in Canada is similar to that in the United States. One important exception is the export of glass containers to the United States in the form of beer sales.

The loss of market by glass containers appears to be part of a long-term trend. Glass is a heavy material compared to aluminum, cardboard, and plastic, thus costing more to handle

TABLE 9.1

GLASS CONTAINER PLANT CLOSURES
IN THE UNITED STATES (1980-1985)

Firm	Number of Closures	Closure Locations
Owens-Illinois	8	New York, Louisiana, Massachusetts, New Jersey
Container General Corp.	6	Indiana, Missouri, Texas, Mississippi
Brockway Inc.	3	Minnesota, Pennsylvania
National Can	3 (including 2 inactivated)*	Pennsylvania, New Jersey, Massachusetts
Anchor Glass (Wesray Inc.)	1	Indiana
Ball Glass	2	-
Kerr Glass	-	-

* The term "inactivated" is understood to refer to "mothballing" the plant, a temporary closure.

TABLE 9.2

MAJOR GLASS CONTAINER FIRMS
IN THE UNITED STATES (1985)

Firm	Number of Plants	Location
Owens-Illinois	14	
Container General Corp. (Diamond-Bathurst) Chattanooga, TN	12 (15% of market)	California (3), Connecticut, Georgia, Indiana, Louisiana, Ohio, Pennsylvania, Texas, Tennessee, West Virginia
Brockway Inc., Brockport, PN	11	Pennsylvania
Anchor Glass (Wesray Inc. includes Midland Glass)	10	New Jersey, Ohio
Thatcher Glass, Greenwich, CN	6	Florida, New York, Indiana, California, New Jersey, Illinois
Ball Glass	6	-
Kerr Glass	-	-

and transport. It is energy-intensive, especially if manufactured without cullet. It is breakable. With these disadvantages, it is possible that glass will continue to lose ground in the container industry--a negative trend for silica producers (ref. 9.22, 9.23, 9.24, 9.25).

9.2.4 Changes in the Motor Vehicle Glass Market

As one of the biggest consumers of glass, the motor vehicle market poses several key questions for silica producers. First, what is the effect of the popularity of imported automobiles? One negative effect is the use of automobile glass from Japan, Germany, etc. by the manufacturers and the decrease in use of domestically produced auto glass. However, many non-North American auto manufacturers are setting up plants in North America.

Secondly, what are the effects of the growth in market share of small autos? Small cars use less glass--a negative effect.

Thirdly, what are the effects of gas mileage restrictions on cars? Glass is relatively heavy so there is an interest in producing a lighter glass or glass substitute. This would have negative effects on silica producers. On the other hand, there is a growing use of microprocessors and composite materials (like fibreglass) in cars. Many of these materials use silica and represent a market opportunity for silica producers. Probably the automotive use with the greatest potential is silicon carbide ceramic for diesel engines. Tests to date have been positive.

Fourthly, what is the future of the automobile? Through the 1970s many commentators predicted a gloomy future for the car. These predictions were based upon gasoline shortages, traffic tie-ups, and air pollution. However, the car has survived, and it appears that it will survive for some time to come.

Overall, it appears that motor vehicle production will remain an important consumer for at least twenty to twenty-five years. However, the quantity of glass used per vehicle will likely decrease, meaning that this market is a mature or decreasing market for silica, barring a significant technical breakthrough.

9.2.5 Market for Quartz Crystal

This market has remained static over the last few years. The material is consumed by the electronics, computer and optical instruments industries, and its demand should remain steady or grow in the long-term. Of the seven firms which produce quartz crystal, two are within economic transportation distance of the Maritimes--AT&T Technologies Inc., North Andover, MA and P.R. Hoffman Co., Carlisle, PA.

A cautionary note should be made here regarding silica use in electronics and computers. Although the silicon chip has become synonymous with high-tech developments in these fields, it could face competition from other semiconductors. Gallum-arsenide, for example, is presently receiving extensive research and development work. It has several advantages over silicon including: greater resistence to extraneous radiation, faster electron mobility, and the ability to handle analog signals (ref. 9.26).

It is unlikely that this market would represent an important consumer of Maritime silica.

9.2.6 Solar Applications

Many devices which are intended to capture solar energy use silica. Examples include greenhouses and solar collectors which use flat glass and photovoltaic cells which use silicon metal. While growth in the solar applications market has been slow, it has been steady and could represent a significant consumer of silica in the future. The rate of growth hinges on increasing the conversion efficiency and/or reducing the production cost of the devices. Recent technological advances promise both (ref. 9.27).

9.2.7 Changes to Silicon Carbide Market

At present the silicon carbide industry is in a slump. Between 1979 and 1983, production dropped from 0.176 M tonnes to 0.098 M tonnes, and several plants were shut down (Carborundum in Vancouver, WA and Ferro in Cap-de-la-Madeline, PQ). This drop reflected a drop in demand for abrasive material in heavy industry. Thus, the industry needs to be revitalized. Some recent developments may help: new ceramic diesel engines utilizing silicon carbide, cutting tools using silicon ceramics, silicon carbide whiskers with superior tensile strength and high temperature performance, and new silicon carbide refractories.

The new ceramic diesel engines appear to have great promise, with several very large firms working on their research and development. These firms include General Motors, Hitachi Chemical Co. Ltd., Carborundum Resistant Materials Co., W.R. Grace & Co., and Feldmuekle AG (ref. 9.28).

Another new application, developed by Ford Motor Co., is a silicon nitride ceramic for cutting tools. It allows much faster machining of cast iron (ref. 9.29).

Silicon carbide whiskers and fibres are now being made by Nippon Carbon Co. Ltd. for use in reinforcing ceramic composites and aluminum-based metal matrix compounds (ref. 9.30).

The new developments certainly improve the market outlook for silicon carbide for the long-term. However, in the short-term, it is likely that production of this energy-intensive material will continue at or near its current level for the near future. (U.S. Bureau of Mines Mineral Yearbook 1983.)

9.2.8 Changes to the Ferrosilicon and Silicon Metal Markets

The situation for these markets is not good, especially for American ferrosilicon producers. The problems are excess capacity and low prices. For example, ferrosilicon producers in Iceland, Norway, Sweden, Yugoslavia, and Venezuela were accused of dumping their product in the European Economic Community (EEC) in 1983. Despite these problems, many Third World countries (Yugoslavia, Egypt, Philippines) are expanding their production. This will exacerbate the problem.

The silicon metal market is dependent upon aluminum production which in turn has had difficulties in the 1980s. As with ferrosilicon, a tight market will become more crowded as more silicon producers come on line (Brazil, Iceland, Norway, Australia) (ref. 9.31).

Both ferrosilicon and silicon metal are energy-intensive products, so it is not surprising that extensive research has been devoted to reducing the energy required for production. Among the technologies investigated for energy reduction include heat recovery systems and plasma arc smelting. The latter process can accept lower grade ore and more fines than existing

furnaces. Because of the high energy component of ferrosilicon and silicon metal, Canadian producers should fare better than American producers.

9.2.9 Increased Recycling of Glass

Glass is recycled for containers in two ways. The first is reuse, mainly refilling beverage bottles. Breweries, wineries and soft drink bottlers have refilled bottles for years. The second reuse is remelt, using broken glass or glass cullet as raw material for glass furnaces.

The use of glass cullet has many advantages, including lowering the melting temperature--thus saving energy, reducing pollution emissions, and extending furnace life--by as much as 20 to 30 percent.

At present, much of the cullet used is in-house scrap from glass plant operations. However, manufacturers are using more and more glass cullet collected outside the plant. According to Gifford Stack of the Glass Packaging Institute (GPI), the glass industry tripled its level of cullet use between 1978 and 1981, reaching 6 percent of production. The GPI's aim is to reach 25 percent in the mid-1980s.

Owens-Illinois is a leader in glass recycling and used 30 percent cullet for its raw furnace feed in 1984. The firm had 14 reclaim glass processing centres in operation in 1984.

Owens-Corning Fiberglass is the leader in using cullet for fibreglass. Its plants in Delaware, New York, and California use between 20 and 50 percent cullet in their furnaces. The company has found that using 30 percent cullet reduces silica requirements by 60 percent, soda ash requirements by 40 percent, and energy requirements by 10 percent.

The price for glass cullet is a function of the price for raw materials (silica, soda ash, lime) and energy and have fluctuated greatly in recent years. However, cullet supply is not strictly a function of price, as many communities have mandatory and subsidized recycling programmes which ensure a steady supply. Furthermore, many glass manufacturers, notably Owens-Illinois, have invested in cullet processing facilities.

Prices for glass cullet were reported at $60-$83 (US) per tonne in 1982. Approximately 0.41 M tonnes of cullet was recycled in 1982, 0.45 M tonnes in 1983 (ref. 9.32, 9.33).

This is a long-term trend which will adversely affect silica producers.

9.2.10 Fibreoptic Applications

A major development in communications is the replacement of copper wire with fibreoptic cables made of glass fibre. These cables have lower costs, better and larger transmission capabilities and a lower level of interference from electrical signals. Telephone systems across North America are replacing copper wires with fibreoptic cable on major interconnections.

This is a long-term trend which should benefit silica producers. The quantity of silica which will be used is unknown.

9.2.11 Changes to the Foundry Industry

During the early 1980s, American heavy industry suffered greatly from recession as declining demand and low-priced imports reduced demand for domestic steel and other ferrous products. Recovery for heavy industry has been slow and there are many

experts who think that heavy industry in America may never again reach the production levels of the 1960s and 1970s--let alone exceed them. The reason for this contention is that many developing and Third World countries can produce quality ferrous products at a much lower cost and that American capital resources would be better spent on "post-industrial" projects such as electronics or telecommunications developments.

In the short-term there will be some recovery of the foundry industry, but it is doubtful that it will expand beyond levels of the 1960s and 1970s before the year 2005.

9.2.12 Changes in the Refractory Materials Market

Several important refractories contain silica including: silica, silica brick, silicon carbide, and fire-clay brick. These refractories are used by industries which require materials with thermal resistence or conductivity, chemical inertness and physical strength for high-temperature applications in kilns, furnaces and boilers.

Among the industries which use refractories are: foundries, glass plants, potteries, smelters, lime plants and ceramic plants. As mentioned elsewhere, several of these industries (especially foundries and glass plants) are experiencing long-term decline which, in turn, reduces demand for refractories.

9.3 Summary

The long-term trends for silica producers are mixed. On the supply side, there is little doubt that silica deposits will become more difficult and expensive to develop, even with advanced technology. Long-distance sourcing will become more common. The result of these trends should make American, Quebec and Ontario markets more attractive to Maritime producers. See Table 9.1.

On the demand side, there are several conflicting trends. In the United States, the largest users are the glass container industry (26-34 percent), foundries (25-27 percent), sand-blasters (7 percent), the petroleum industry (specifically hydraulic fracturing, 3.7-5.6 percent), fibreglass producers (4.1-5.5 percent) and flat glass producers (3.6-4.9 percent). In Canada, the largest users are glass manufacturers (including fibreglass, total 42 percent), smelters (15 percent), foundries (13 percent), refractory brick mixes and cements (10 percent), metallurgical (6 percent), concrete products (5.7 percent) and artificial abrasives (4.3 percent). Almost all of the above users are in difficulties at present. Many of them are facing long-term stagnation or decline.

Two industries in particular--glass-making and heavy industry--are facing changes which will adversely affect silica producers. Markets for glass containers are declining, and markets for auto glass are stagnant. Flat glass production is lead by the construction industry and should remain steady into the long term. However, even flat glass is affected by the increasing use of cullet as a feedstock. Thus, silica producers face an unpromising future in supplying glass producers.

Heavy industry is presently undergoing a fundamental long-term change in the United States. Older mills are closing, and much of their market is being met by imported products from Europe, Canada and the Third World. The result of these changes is that markets for foundry sand, smelter flux, ferrosilicon and silicon carbide are shrinking. Thus silicon producers face an unpromising future in supplying silica to heavy industry.

Not all the news is gloomy, however. Several new silica applications are being developed. Of particular promise are fibreoptics and ceramics. The question is whether these new

TABLE 9.3

DESCRIPTIVE SUMMARY OF LONG-TERM TRENDS ON SILICA MARKETS

(Legend: + means enhancement of market for Maritime producers
- means lessening of market for Maritime producers
o means minimal or no effect on market potential)

Trend	New England					Middle Atlantic						South Atlantic				Gulf of Mexico				Canada	
	ME	NH	MA	RI	CN	NY	NJ	PN	DE	MD	VA	NC	SC	GA	FL	AL	MS	LA	TX	PQ	ON
Supply																					
- Land use conflicts	+	+	++	++	++	++	++	++	+++	++	++	+	+	+	++	+	+	+	+	+	+
- New deposits	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
- Safety and health	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	++
- Environmental legislation	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
- Environmental constraints	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
- Reserve depletion tax benefit	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	o	o
- Technological developments	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Summary	+++	+++	++++	++++	++++	++++	++++	++++	+++ ++	++++	++++	+++	+++	+++	++++	+++	+++	+++	+++	++	+++
Demand																					
- New silica construction products	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
- Decline in glass container use	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
- Changes in motor vehicle glass market	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
- Quartz crystal	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
- Solar application	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
- Changes to silicon carbide market	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
- Changes to ferrosilicon and silicon metal markets	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
- Increased recycling of glass	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
- Fibreoptic applications	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Summary	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Overall Summary	++	++	+++	+++	+++	+++	+++	+++	+++ +	+++	+++	++	++	++	++	++	++	++	++	+	++

applications will replace demand lost in traditional markets. In the short term, the answer is likely no; in the long term, the answer is maybe (see Table 9.3).

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10. RESERVES OF PRESENT SUPPLIERS

10.1 General

In this section we examine the reserves of present suppliers of silica sand and lump silica to areas where some market penetration by Nova Scotia/New Brunswick suppliers might be achieved. For a relatively low value product such as silica, the term "reserves" should be considered with caution. Firstly, as reserves at one source become depleted, exploration efforts to locate alternative sources would be enhanced. Secondly, known sources of inferior quality silica might be beneficiated to meet rigorous specifications should this prove economical. Thirdly, since silica and silicates constitute 26 percent of the earth's crust, silica cannot be considered a scarce mineral, but rather unlimited in resources. Fourthly, as the costs of energy and labour have increased, the raw material cost for silica products has decreased to a point where it is economic to import silica over long distances.*

10.2 United States

Because of the abundance of silica, it is difficult to determine reserves in the usual sense of the term (that is, M tonnes per state, years of supply). Presented below is a brief description of major depositions in the United States.

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* A notable example: silica from northern Norway is shipped 2600 km to Iceland for ferrosilicon manufacture.

"Silica deposits have formed in all geological eras from the Precambrian to the present. The Sioux quartzite of South Dakota, the Nesnard quartzite of Michigan, and the Dripping Spring quartzite of Arizona are all Precambrian in age. Lower Paleozoic sandstones and quartzites are widespread in the United States and especially pure. The Cambrian Addy quartzite occupies over 250 square miles in Stevens County, WA, and is used as a source of silica for the production of ferrosilicon and silicon metal in the Pacific Northwest. The Ordovician Eureka quartzite and related stratigraphic units extend over 100,000 square miles from Idaho to southern California and have numerous sections that contain from 95 percent to 99.9 percent SiO_2. The Ordovician St. Peter sandstone and the Devonian Oriskany quartzite in the eastern interior have been sources of glass and foundry sand for almost a century. A large portion of the metallurgical pebble used in the production of silicon alloys comes from the Sewanee, Sharon, and Olean conglomerates of Pennsylvania age on the western side of the Appalachian Mountains. Metallurgical-grade material is also quarried from the Cambrian Erwin and Silurian Tuscarora quartzites on the eastern side of the range in Virginia and West Virginia. Although sandstones deposited since Paleozoic time are widespread and sometimes of high purity, few rival the earlier deposits in extent and purity. At least one ferroalloy producer uses Pliocene to Holocene terrace gravels from the Carolinas. Most of the Paleozoic and Mesozoic quartzites in the interior Western States have not been intensely exploited because of transportation costs.

> Silica in the form of quartzite, sandstone, and vein quartz is abundant in virtually every part of the world".
>
> (U.S. Bureau of Mines and Mineral Facts and Problems, "Silicon" (1985), p. 4.)

The reserve status of specific deposits is not known (either in tonnes remaining or years of reserves).

10.3 Ontario

As identified in Section 8, Market Evaluation, Indusmin Limited/ Limitée dominates silica production in both Ontario and Quebec. In Ontario, this company is the sole producer of glass grade silica sand; it being processed in Midland from a quartzite quarry 225 km away on Badgeley Island in northern Georgian Bay. The total silica production from this source was reportedly 399,000 tonnes in 1979 and 427,300 tonnes in 1981. Two grades of silica are produced; the first grade being plus 2 inch material for direct use in the ferro-alloy industries. The second grade (minus 2 inch) is shipped by self-loading lake vessels to Midland where it is processed to meet glass sand specifications. Proven reserves in 1982 were 13 million tonnes. At 400,000 tones per annum, this source would be depleted in 25-30 years.

10.4 Quebec

10.4.1 Sand

Indusmin also produce from silica deposits at St. Donat and St. Canut in Quebec. The St. Donat operation is relatively small when compared with Badgeley Islands; 90,700 tonnes of quartzite

reportedly being mined annually from proven reserves (1982) of 1 million tonnes. At this production rate reserves will be depleted within 8 years. After preliminary crushing and screening the minus 6 mesh material is trucked to the mill at St. Canut, where it is reduced further to sizes meeting sandblasting and silicon carbide requirements.

At St. Canut, Indusmin quarry sandstone of the Potsdam Formation which occurs over a wide area in southeastern Ontario and southwestern Quebec. Annual production from the St. Canut quarry is approximately 300,000 tonnes. Reserves are variously estimated at 14.5 million tonnes and 17.4 million tonnes, sufficient for at least 35 years further production. The Canut plant produces silica for glass and foundry sand and for silicon carbide, autoclaved concrete, asbesetos pipe and ceramic industries.

Silica sand is also produced in Quebec from a natural sand deposit by Les Mines de Silice de Montréal Ltée near Ormstown some 60 km south of Montreal. Annual production is reportedly 40,000 tonnes out of proven reserves of only 280,000 tonnes. Product is sold to the Fibreglass Canada Inc. plant at Candiac in Montreal; to foundries in Quebec, and to the construction industry for blast sand, etc.

Another, potential source of silica is the Magdalen Islands (see Section 9.1.3).

10.4.2 Lump

Several producers of lump silica operate in Quebec. Baskatong Quartz Inc. produce lump silica, principally for SKW Canada Inc. at Bécancour but also for Union Carbide plants at Chicoutimi and Beauharnois. Reserves of high quality quartzite have been estimated at 2 million tonnes. Baskatong have also been involved

with delineation of a small, very high quality silica deposit at Saint-Ludger in the Lac Mégantic area. This deposit had estimated reserves of 100,000 tonnes to a 20 metre depth. It is being exploited by Mines Lorna Lily Inc. for silicon metal production by SKW at Bécaucour.

Armand Sicotte & Fils Limitée have developed a silica rich sandstone deposit at Sainte-Clothilde with estimated reserves of 5 million tonnes.

Union Carbide and the Société Miniere Melocheville Limitée exploit silicious sandstones at Beauharnois. Union Carbide reserves of 10 million tonnes are only being developed at 40,000 tonnes per year because of a decline in ferrosilicon production at the Beauharnois plant. The Société Miniere Melocheville Limitée produce approximately 70,000 tonnes of lump silica per year destined for Chromascos ferrosilicon and manganese-silicon plants.

11. ESTIMATES OF SHORT-TERM AND LONG-TERM DEMAND

11.1 Introduction

Silica sand is used in many different industries for a great many products. As discussed in Section 9, some of these industries are presently declining (foundries, for example) while others are expanding (industrial ceramics and electronics). Thus, projecting the growth in silica demand is a difficult task which involves accounting many differing trends.

For this report, both short-term and long-term trends were projected. "Short-term" was defined as the 1985 to 1989 period, while "long-term" was defined as the period until 2005.

Short-term trends were projected based upon studies done elsewhere. In particular, the United States projections are based upon information selected from the publications "1985 U.S. Industrial Outlook" supplied by the United States Department of Commerce, and "Sand and Gravel in 1984" supplied by the United States Bureau of Mines. Canadian projections are based upon information drawn from Statistics Canada (specifically catalogues 64-001 and 44-207) and The Financial Post's "Report on the Nation, 1986." Information from these publications is presented in graphical form throughout this section.

Long-term trends were based upon the researchers' assessment of market growth as developed from a review of short-term trends (above) and the evaluation presented in Section 9.

It should be noted that all dollar-based projections are based on constant dollars.

11.2 Construction Products

United States

After a decline which lasted from 1972 to 1982, the American building market recovered strongly in 1983 and 1984. According to the U.S. Department of Commerce, residential construction declined by 3.3 percent from 1972 to 1984, an average of 0.3 percent per year, while nonresidential construction grew by 20.2 percent (1.8 percent per year). In total, building construction grew by 6.8 percent or 0.5 percent per year. See Figure 1.1*.

For the short-term (until 1989) the U.S. Department of Commerce is predicting an annual growth of 1.5 percent in residential construction and 4.0 percent in nonresidential construction, or 2.8 percent in total construction expenditures.

In the long-term, building construction should continue to grow in the United States. The population is growing steadily and the economy is healthy. Fluctuations will occur, but the trend will be for growth, not decline.

The prospects for silica producers from building construction growth are good (likely 2.0 percent). At present, various construction products (flat glass, fiberglass, sand paper, ceramics, roofing, scouring cleansers, fillers) represent about 12 percent of total current silica consumption, and their use should expand with the construction market. New products could increase consumption further.

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*"Private building" excludes all municipal, state, and federal (including military) government building projects (residential and nonresidential).

U.S. Private Building Construction

Historic and Projected

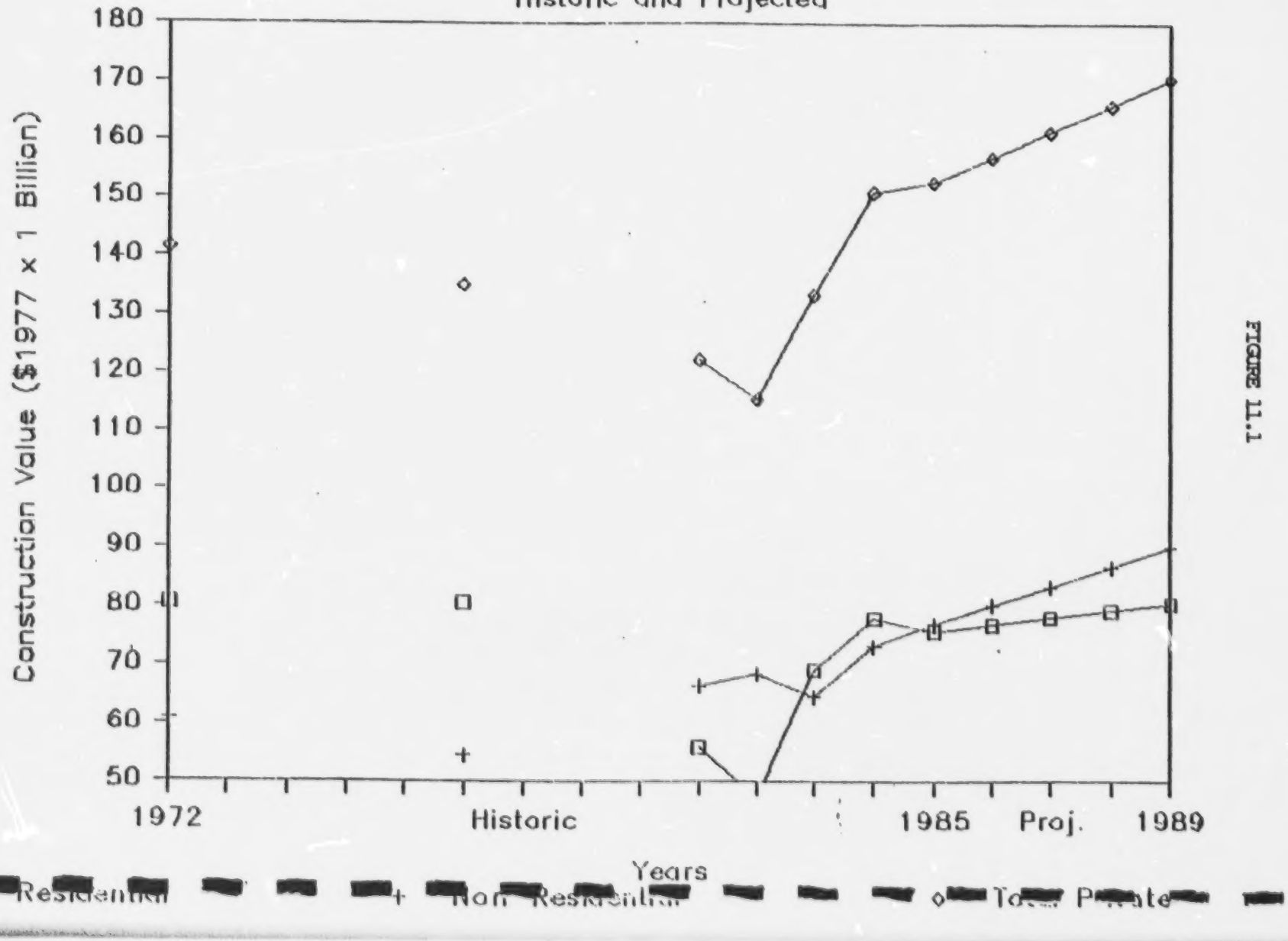

FIGURE 11.1

Canada

As opposed to those in the United States, the Canadian building construction prospects will decline in the short-term. Until 1989 residential construction will decline 3.6 percent per year; nonresidential construction, 1.3 percent per year; and total construction, 2.5 percent per year. See Figures 11.2, 11.3 and 11.4 for the total Canadian and Ontario and Quebec, respectively, annual construction values.°

In the long-term, until 2005, some recovery should occur as the population grows and the economy expands. A value of 2.0 percent per year is assumed for growth in this period, the same as for the United States.

For Canada, the building industry is assumed to include fiberglass (estimated at 0.08 M tonnes in 1981) and concrete products.

11.3 Glass Container Products

United States

In the 1980 to 1984 period, American glass container production declined 12.9 percent (3.4 percent per year) as producers faced a twin attack of imported containers and alternate container materials (aluminum, plastics, foils). According to the U.S. Department of Commerce* the decline has stopped and glass container producers should experience slight growth through to 1989 (0.9 percent per year). See Figure 11.5.

°The figures in Figure 11.2 are for residential and nonresidential construction and include single, seasonal, double, row, and apartment housing, building conversions, alterations, and improvements, new industrial, commercial, institutional, and government buildings, and residential garages and swimming pools.

*Ref. 11 - 1985 U.S. Industrial Outlook, U.S. Department of Commerce, 1985)

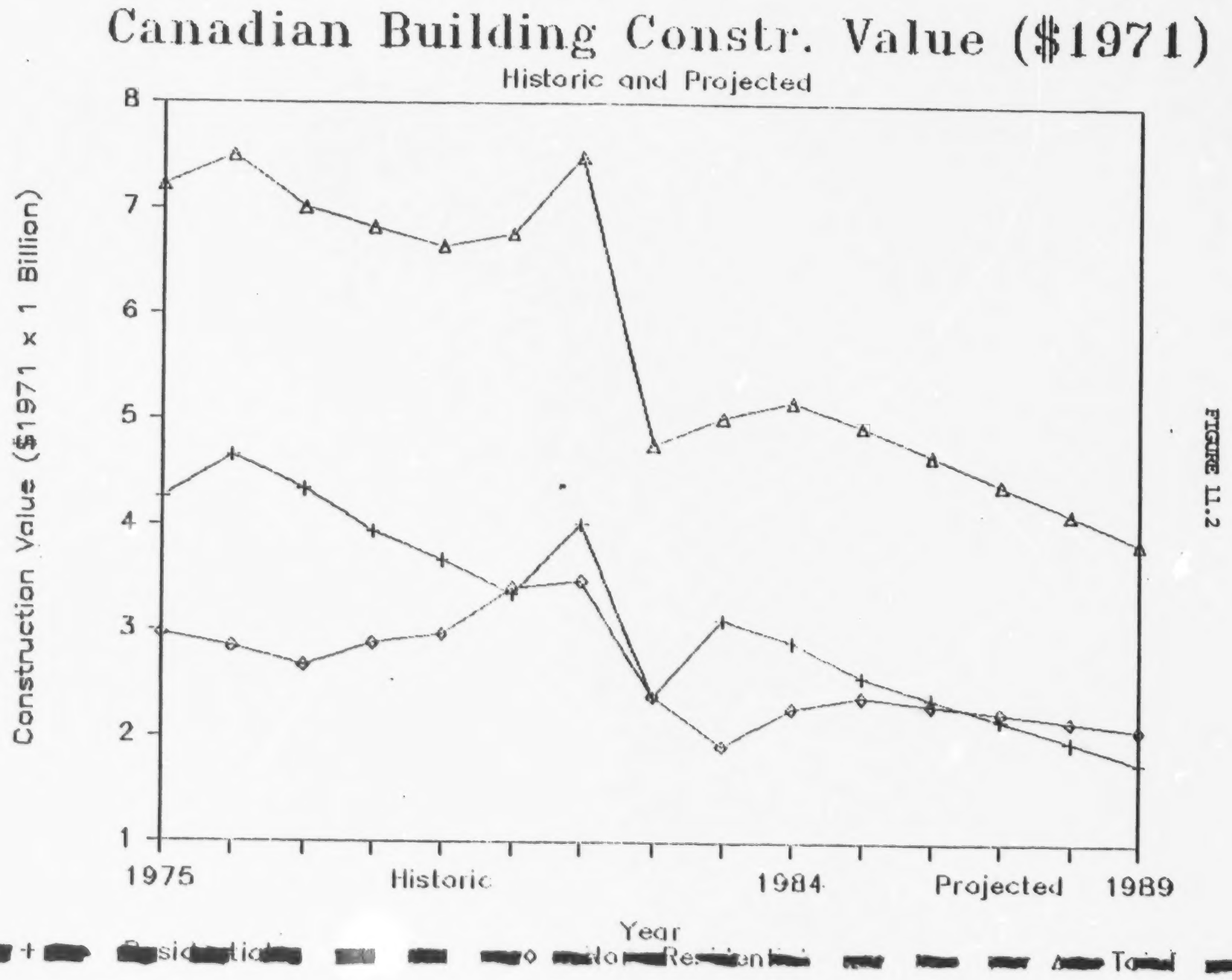
Canadian Building Constr. Value ($1971)
Historic and Projected
Construction Value ($1971 x 1 Billion)
8
7
6
5
4
3
2
1
1975
Historic
1984
Projected
1989
Year
Residential
Total

FIGURE 11.2

Ontario Bldg. Constr. Value ($1971)

Historic and Projected

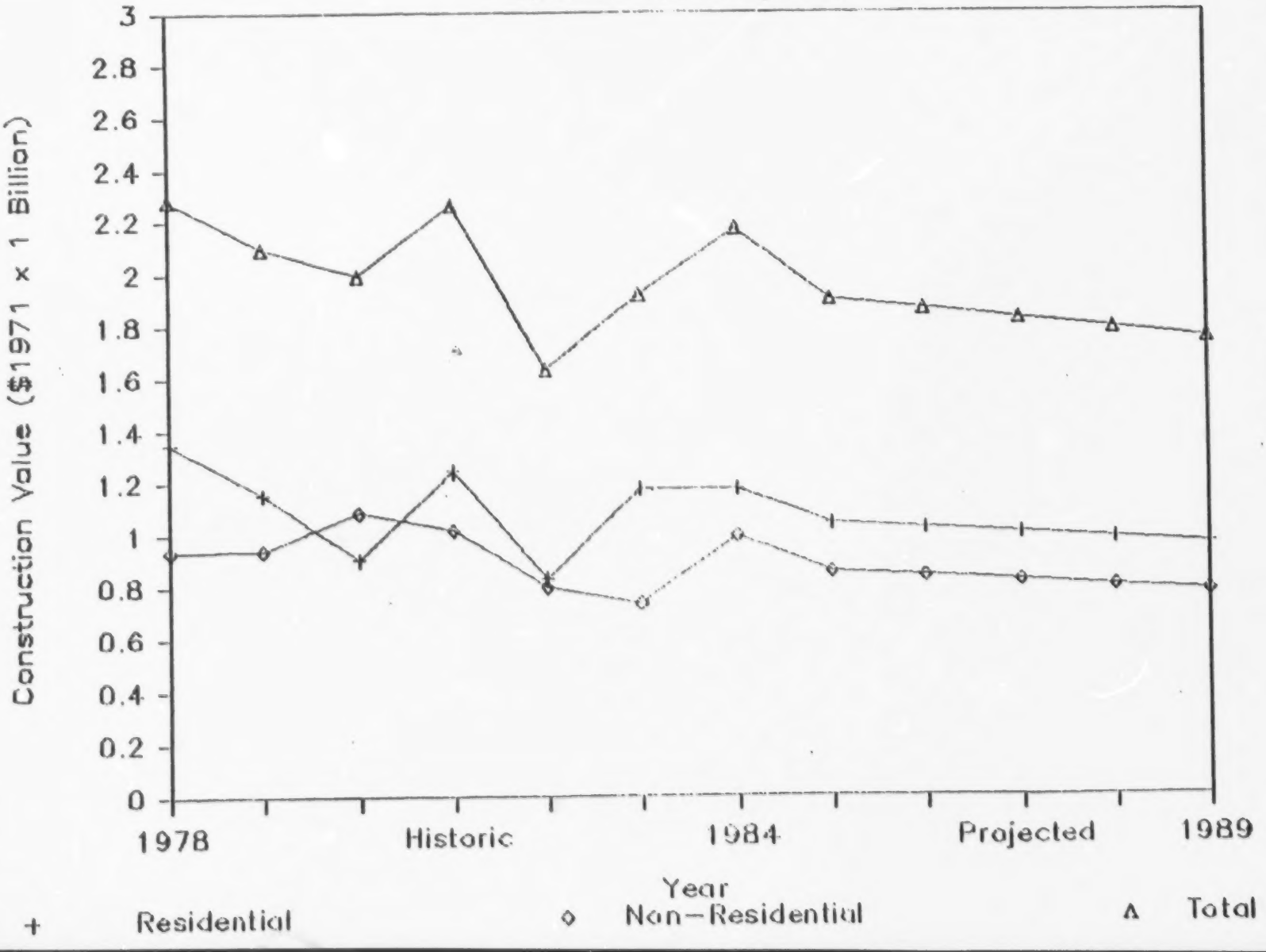

FIGURE 11.3

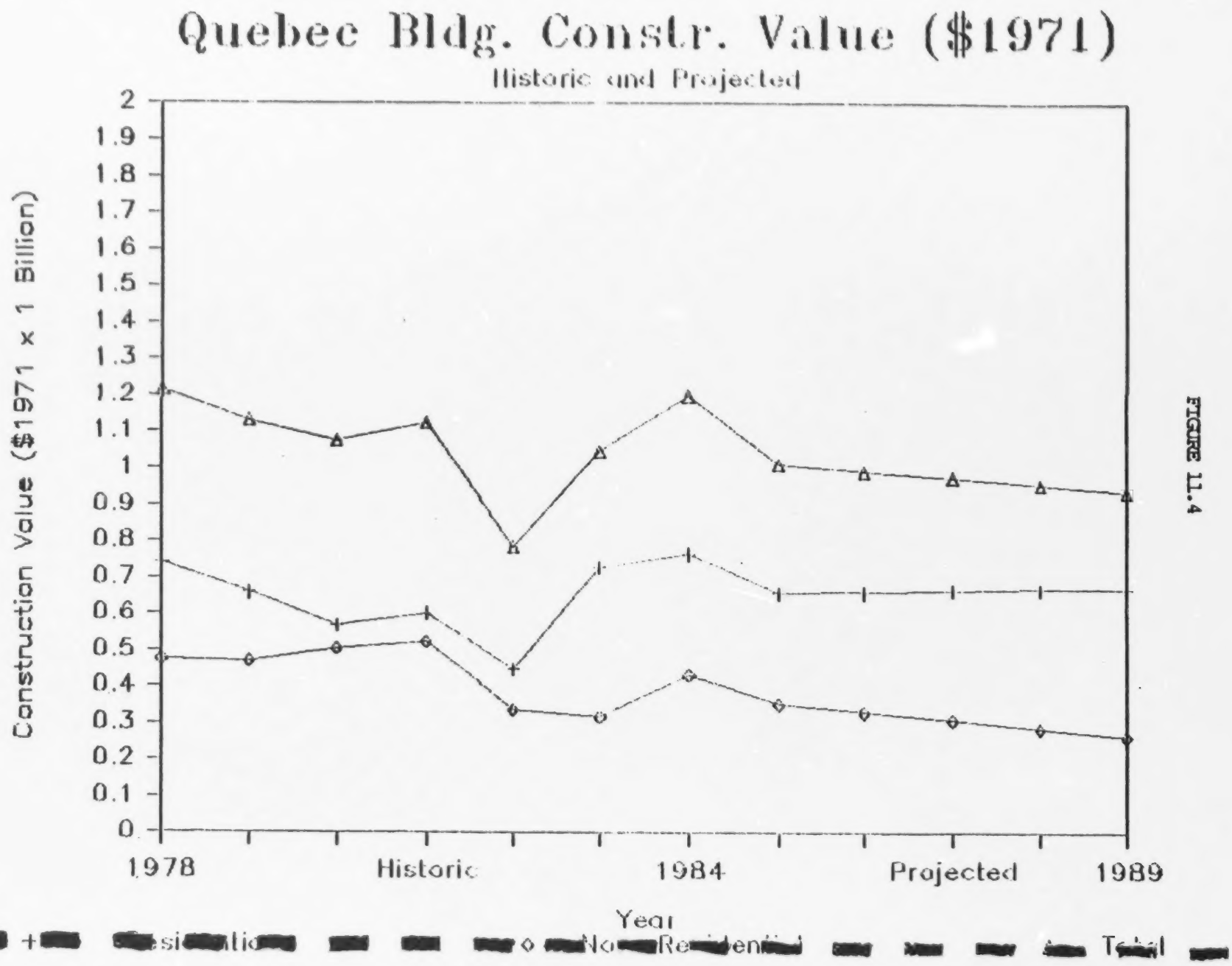
Quebec Bldg. Constr. Value ($1971)
Historic and Projected
Construction Value ($1971 x 1 Billion)
2
1.9
1.8
1.7
1.6
1.5
1.4
1.3
1.2
1.1
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
1978
Historic
1984
Projected
1989
Year
Residential
Non-Residential
Total

FIGURE 11.4

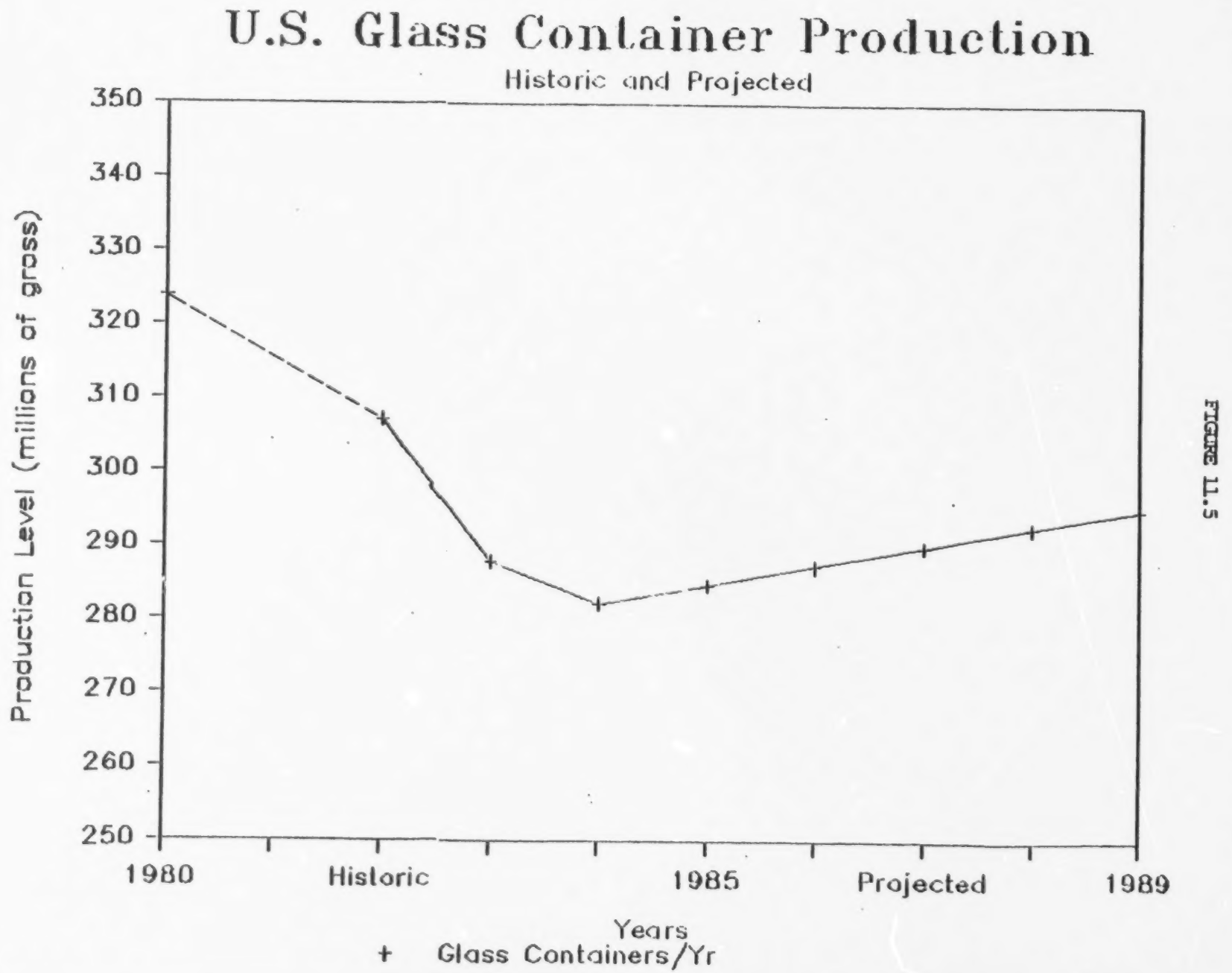
U.S. Glass Container Production
Historic and Projected
Production Level (millions of gross)
350
340
330
320
310
300
290
280
270
260
250
1980
Historic
1985
Projected
1989
Years
+ Glass Containers/Yr

FIGURE 11.5

Projecting growth beyond 1989, it seems unlikely that American production will do more than continue its modest growth (0.9 percent per year). On the other hand, a drastic decline in glass container use is unlikely as well.

What seems certain is that silica use in glass production will decline steadily as a percentage of raw materials input (from 98 percent in 1978 to 75 percent in 1989) as silica is replaced by glass cullet.

Since glass containers represent about 25 percent of the current annual American silica consumption of 27 M tonnes, the change represents a decline of 0.55 M tonnes of annual demand or 2 percent of total demand through to 1989 (see Table 11.1). This means a large volume of silica production capacity (a volume equivalent to that used for ground fiberglass) will either be diverted to other uses or surplus to demand.

Canada

In Canada, the value of glass production (container, flat, specialty) increased steadily in the 1970 to 1982 period. In Quebec production grew by 0.9 percent per year and in Ontario, 2.2 percent per year. Projecting to 1989 glass production should increase by 0.5 percent per year in Quebec and 0.7 percent per year in Ontario. See Figure 11.6.

Beyond 1989, the Canadian glass industry will face problems similar to those in the United States and should experience only slow growth, if any. The outlook for silica supplies to the glass industry is for a stagnant, perhaps declining market as glass cullet increases its share as feedstock for Canadian glass plants.

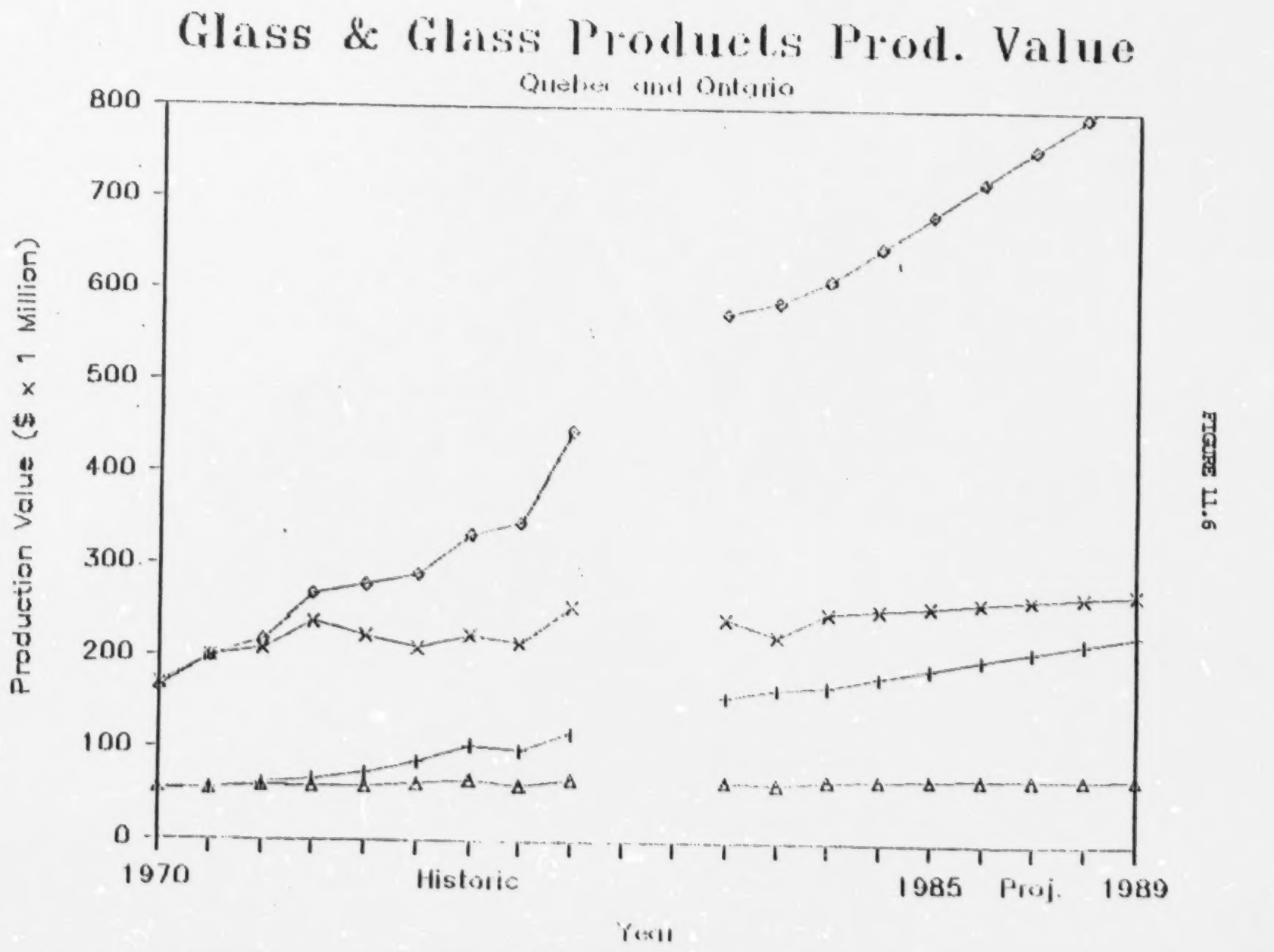
Glass & Glass Products Prod. Value
Quebec and Ontario
Production Value ($ x 1 Million)
800
700
600
500
400
300
200
100
0
1970
Historic
1985 Proj. 1989
Year
X Ontario ($1971)
◊ Ontario ($Curr.)
△ Quebec ($1971)
+ Quebec ($Curr.)

FIGURE 11.6

Independent figures are not available for glass container production in Canada, all glass figures (container, flat) are ambient (see Table 11.2). Projected growth (straight line historic trend) for all Canadian glass production after 1989 is 1.2 percent per year, a higher growth than for the United States because of the inclusion of flat glass in the totals. Flat glass, used for construction, should experience some long-term growth in demand (2.0 percent on its own), while container and specialty glass should grow near the American rate of 0.9 percent. Increased use of cullet should reduce the level of silica in the feed mixture from 98 percent in 1981 to 92 percent in 1989 and 86 percent in 2005.

11.4 Foundry Applications

United States

At present, foundry sand, (moldings and cores, facings) and refractory production account for about 25-30 percent of silica consumption. According to the United States Department of Commerce, over the 1972 to 1984 period, foundry production declined 33 percent or 3.0 percent per year. However, the Department of Commerce estimates that in the short-term (until 1989) foundries will recover and grow at 4.4 percent per year. See Figure 11.7.

The consumption of silica has a direct relationship to foundry production and should grow with the industry in the short-term. However, in the long-term (until 2005) the outlook is not good and it is doubtful that American foundries will produce at volumes greater than those of the 1970s. This is because heavy industry is in decline across the United States, not only as a result of the 1982-1983 recession, but also because of a basic

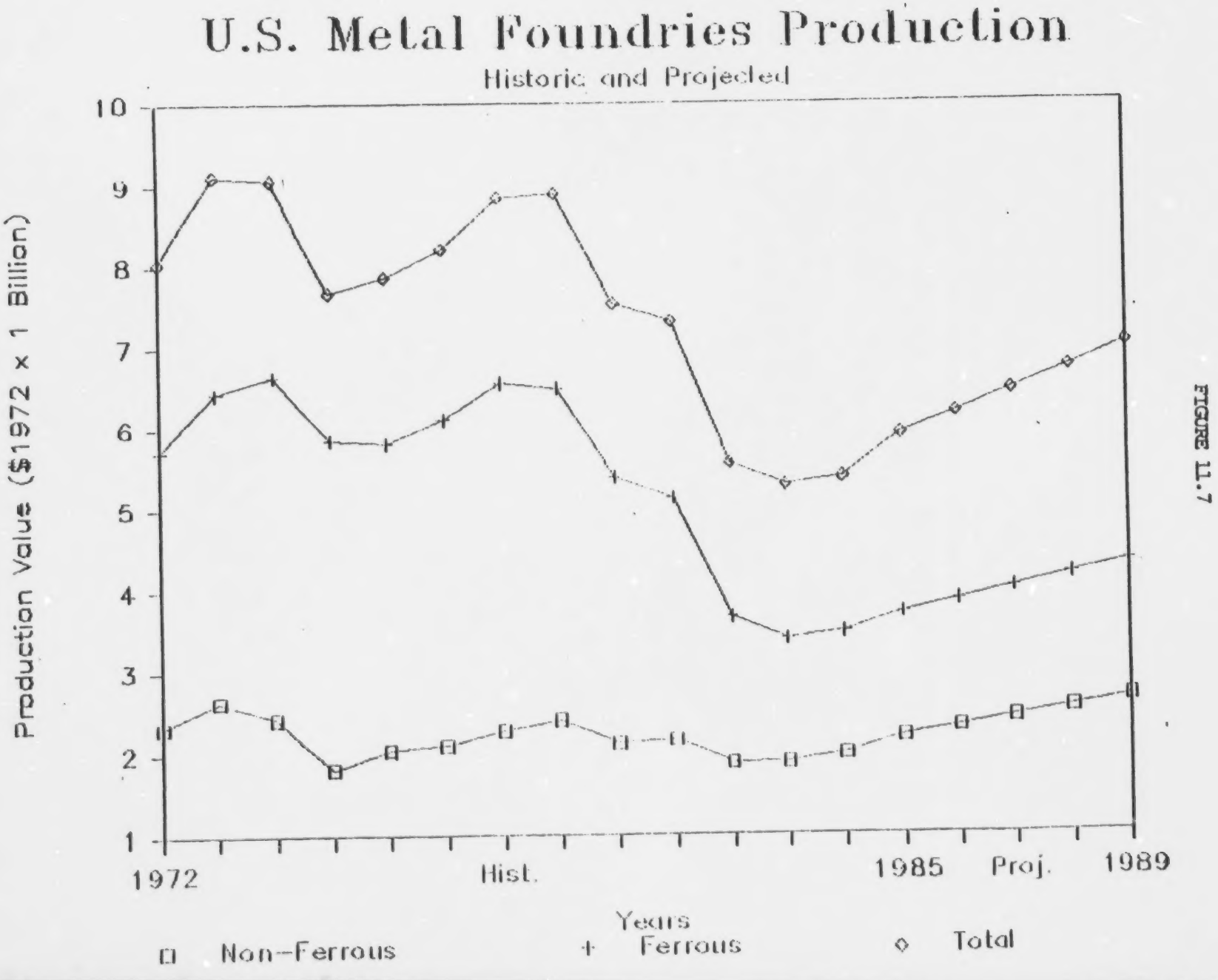
U.S. Metal Foundries Production
Historic and Projected
Production Value ($1972 x 1 Billion)
10
9
8
7
6
5
4
3
2
1
1972
Hist.
1985
Proj.
1989
Years
Non-Ferrous
Ferrous
Total

FIGURE 11.7

restructuring of American industry and the rapid growth of heavy industry (steel-making, foundry) capacity in the Third World (Brazil, Mexico, Taiwan).

Canada

The outlook for Canadian heavy industry is not good either. Based upon straight line historic trend, Canadian foundries are projected to decline 0.02 percent per year until 1989. Beyond that, it is assumed that Canadian foundries will match the growth of American foundries (1 percent per year). See Figure 11.8.

The foundry figures include those for refractory brick.

11.5 Blasting Sand

United States

At present, blasting sand represents about 5-7 percent of total silica consumption. It has had little growth in the 1980s and will likely continue to experience low growth (estimated at 1 percent) into the short- and long-term future. The main reason for this assumption is that although commonly used in building construction, sand blasting has associated health risks (ex. silicosis). As well, other cleaning methods are becoming common.

Canada

For Canada, sand blasting should follow the American trend. It is a minor use and is included under "other uses".

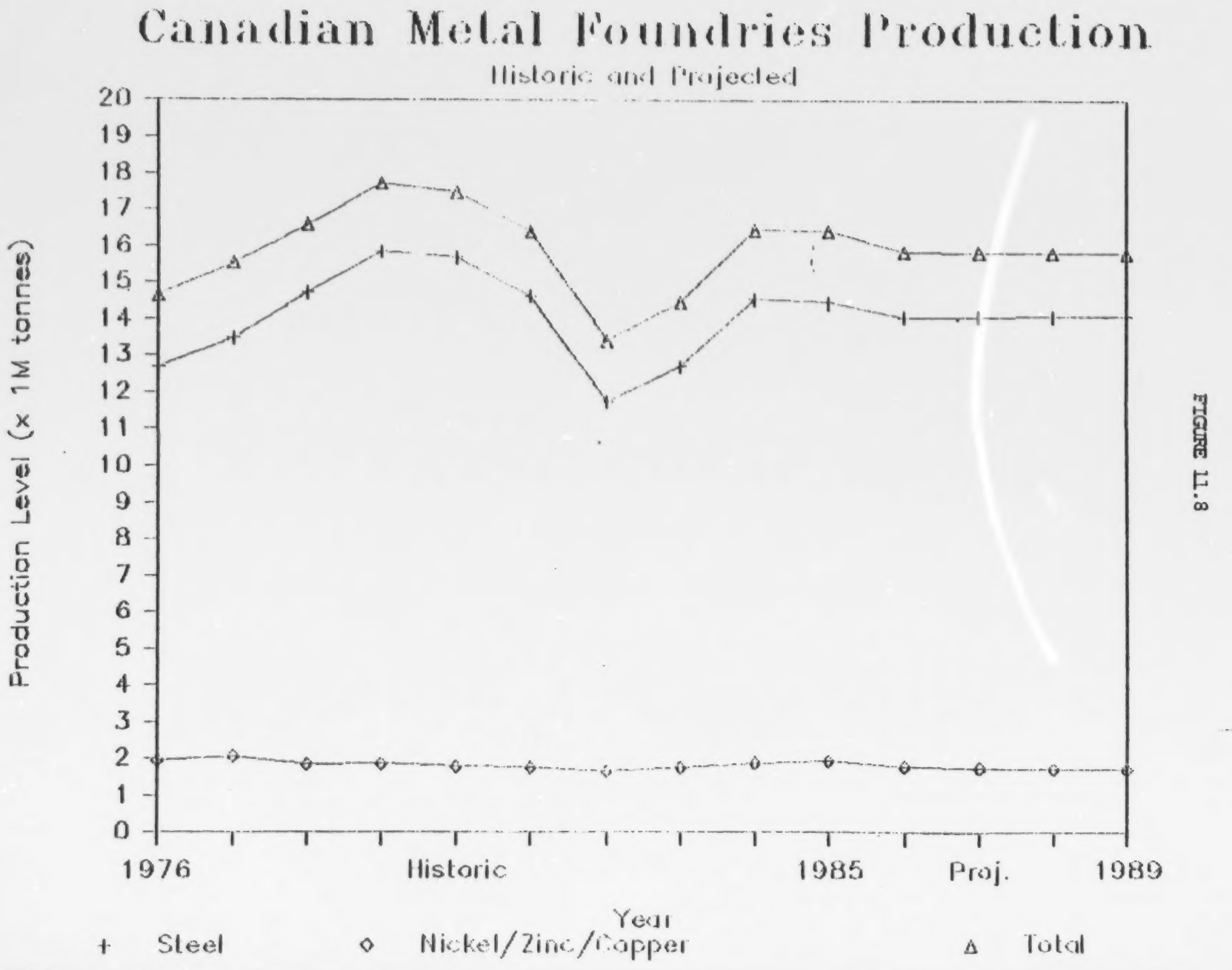
Canadian Metal Foundries Production
Historic and Projected
Production Level (x 1M tonnes)
20
19
18
17
16
15
14
13
12
11
10
9
8
7
6
5
4
3
2
1
0
1976
Historic
1985
Proj.
1989
Year
+ Steel
◇ Nickel/Zinc/Copper
△ Total

FIGURE 11.8

11.6 Silicon Carbide and Advanced Ceramics

The greatest potential for demand growth for silica is in the silicon carbide market. There, the growing research and development in ceramics could result in an explosive growth in demand in the long-term (see section 9.2.7).

Estimating the growth in demand is difficult, for it appears that growth will either be explosive or nonexistent. For the short-term, growth is assumed at 3 percent per year. In the long-term, a value of 10 percent per year is assumed. These estimates are assumed to apply for both the American and Canadian markets.

11.7 Hydraulic Fracturing

United States

In the last few years, high oil prices have encouraged consumption of hydraulic fracturing sand. The sand is used to crack rock formations, increase crack sizes, and prevent cracks from closing, thus increasing oil and gas flow to wells. It is especially popular for use on older wells and helps extend their production life.

Consumption of fracturing sand is dependent upon oil and gas prices and availability. In the short-term, therefore, falling oil prices should result in a flat demand for sand use (2 percent per year). However, in the long-term, demand for fracturing sand should increase steadily (5 percent growth per year).

At present, hydraulic fracturing consumes 4-7 percent of silica.

Canada

At present, the demand for hydraulic fracturing sand in Canada is small and it is grouped with "others" in Table 11.2. Its growth in demand should follow the American pattern.

11.8 Auto Glass

United States

Motor vehicle production consumes silica in a number of forms: specialty (or auto) glass, fiberglass, foundry uses, abrasives, fillers, ceramics, and traction. Some of these uses are considered elsewhere: fiberglass (construction products), foundry uses (foundry applications), abrasives (foundry applications), fillers (construction products) and ceramics (construction products) leaving specialty glass and traction to account for 2.9 percent of silica consumption.

The motor vehicle industry is very cyclical (see Figure 11.9) and sometimes trends are not readily apparent. According to the United States Department of Commerce, the American motor vehicle market declined 3.4 percent between 1972 and 1984 in constant dollars, about 0.3 percent per year. For the short-term (until 1989, the Department of Commerce is forecasting annual growth of 0.6 percent. Long-term trends are difficult to predict as the industry is presently restructuring itself. As a result, it could be revitalized or continue to experience long-term decline (see Section 9.2.4). It is likely safe to assume annual growth of 0.6 percent will continue until 2005.

U.S. Domestic Motor Vehicle Production

Historic and Projected

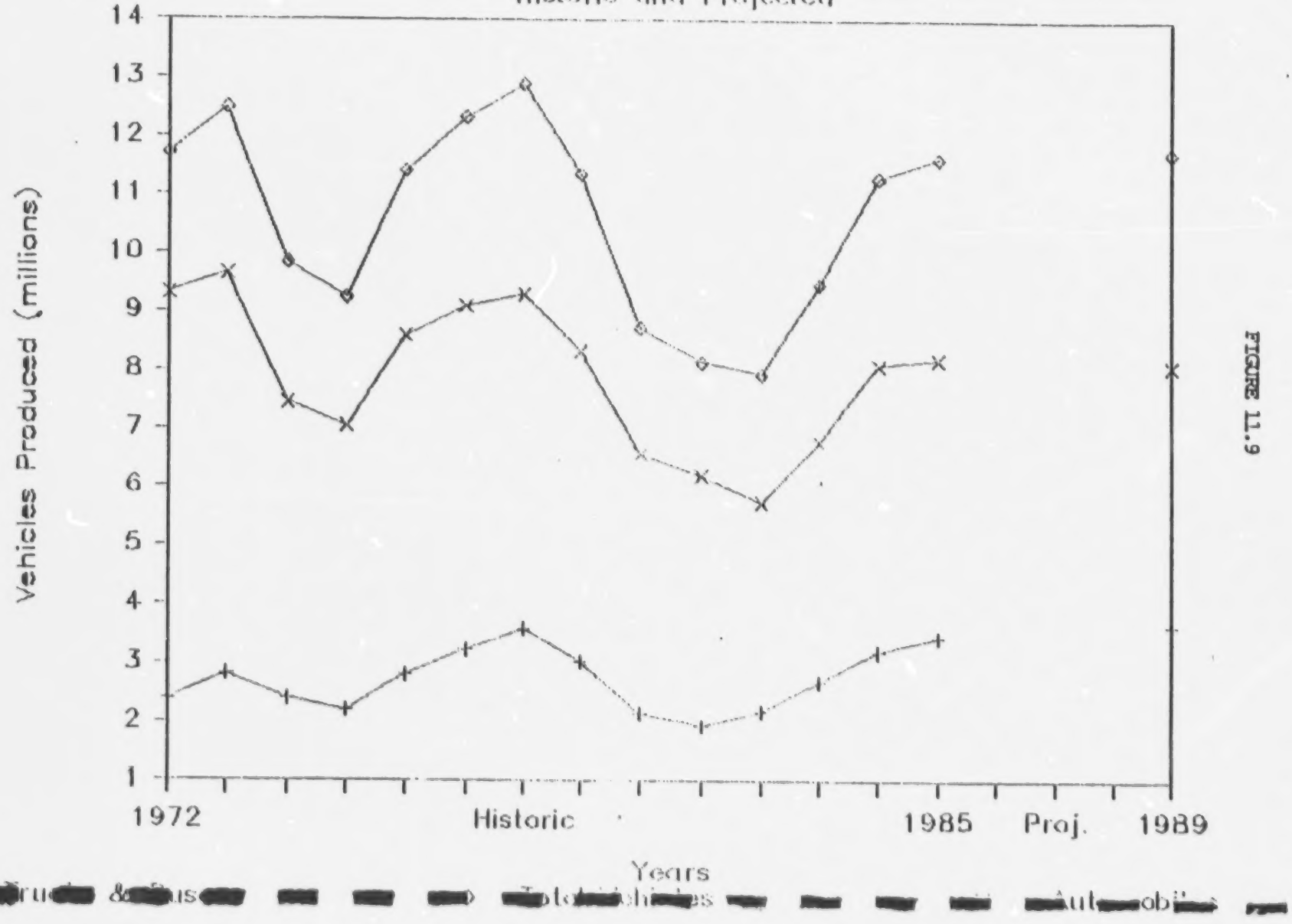

FIGURE 11.9

Growth in silica consumption by the motor vehicle industry will likely not follow that of the industry. Two trends are apparent in silica consumption in the industry. The first is a decline in glass use for headlights and windows as more plastics are used and cars become smaller and lighter. The second is a growth in the use of specialty ceramics for engine parts (see Section 9.2.7). The former trend will result in a silica demand which will remain constant or decline as motor vehicle production increases. The latter trend has the potential for explosive growth in silica use, especially in the long-term. It will be discussed further in Section 11...

Canada

Canadian auto glass production should follow the American pattern as evidenced in Figure 11-10. Its volume is included under the listing "glass production."

11.8 Ferrosilicon and Silicon Metal

United States

At present, ferrosilicon and silicon metal represent about 1.0 percent of the American silica market. The ferrosilicon and silicon metal industries are in a slump in the United States with reduced domestic demand and increased competition from foreign sources.* Because of the low-cost imports, the short-

* The U.S. Bureau of Mines estimates that American production of manganese, chromium and silica ferroalloys as 1990 was 545 customers. Production capacity was 2190 kilotonnes. Estimated capacity for 1990 is 2100 kilotonnes. For Canada 1983 production was 269 kilotonnes, 1983 capacity was 350 kilotonnes, 1990 capacity 370 kilotonnes.

Canadian Motor Vehicle Production

Historic and Projected

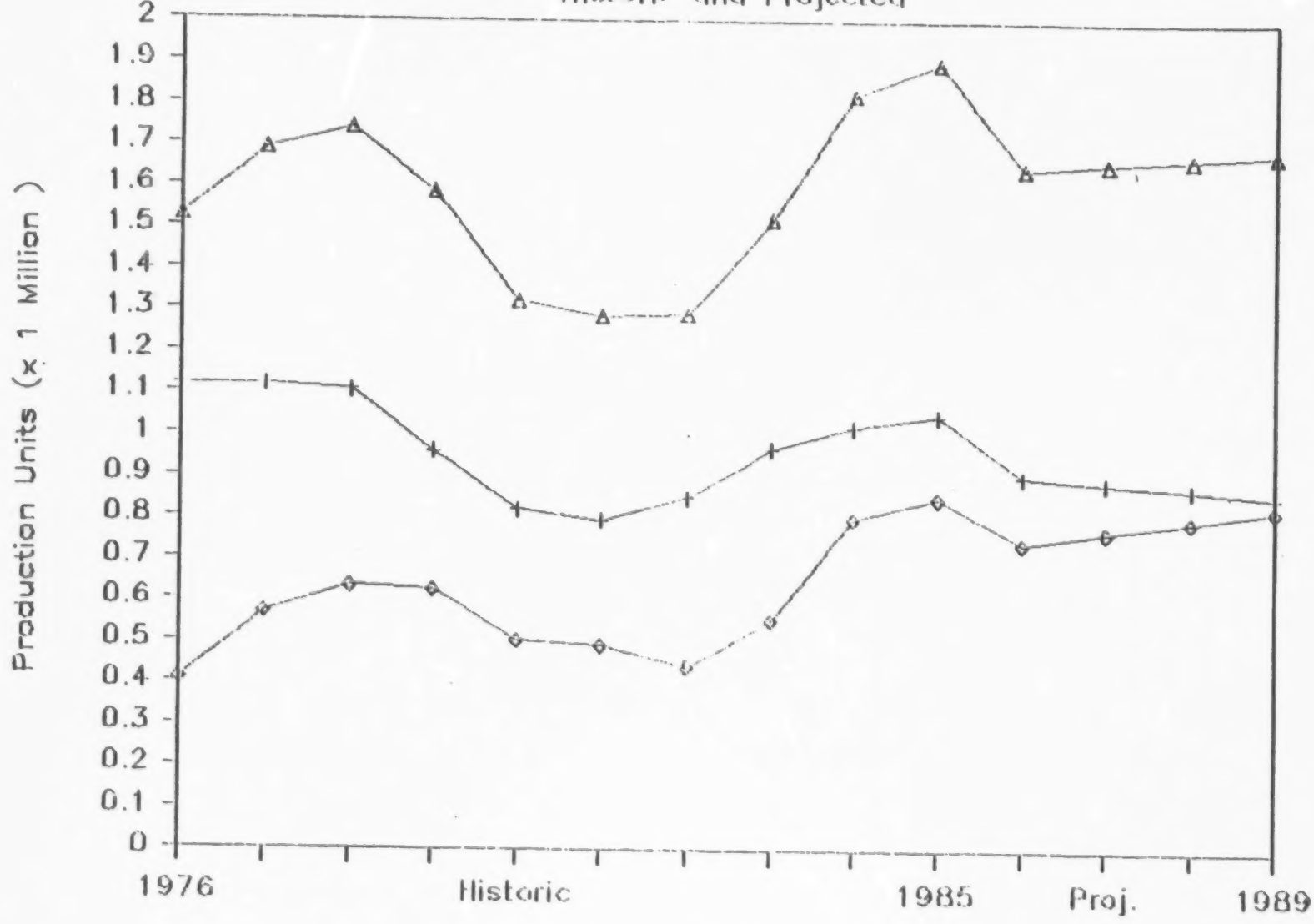

FIGURE 11.10

APPENDIX 1

EXTRACT FROM TERMS OF REFERENCE
(SECTIONS 1, 2 AND 3)

ITEM NO.	DESCRIPTION	QUANTITY	U OF I	UNIT PRICE	TOTAL

1. REQUIREMENT:

To carry out on behalf of the Project Authority, specified herein, an in-depth study to determine and quantify markets for Silica and Silica Sands reasonably accessible from Nova Scotia, New Brunswick, and related areas.

2. BACKGROUND:

A particular goal of the Government of Canada is to correct regional economic imbalance. Energy, Mines and Resources in the 1960's developed mineral agreements with the provinces to stimulate mineral exploration. This initiative eventually came under the umbrella of General Development Agreements administered by and funded in part by the Department of Regional Economic Expansion (DREE). In January 1982 responsibility for regional programs in a particular industrial sector was transferred to the appropriate federal department. New umbrella agreements were developed -- the Federal-Provincial Economic and Regional Development Agreements (ERDA's) — and new Mineral Development Agreements (MDA's) became subsidiary to the ERDA's.

Under the DREE mineral sub-agreements, the provinces delivered most of the programs. With the new agreements, the federal government and the provinces will fund and deliver their own programs. Under the ERDA approach a wide variety of delivery and funding options are available. The federal or provincial party can "deliver" by letting a contract and paying on performance with funding being 100% federal, 100% provincial.

Approval of geoscience, technology or economic development programs by a federal-provincial management committee, having been proposed by appropriate sub-committees, constitutes permission to proceed to put the program in place. A number of economic development programs have been proposed by EMR for federal delivery. This requisition for services covers one such program, relating specifically to the determination of markets and specifications for Silica and Silica Sands.

A number of silica and silica sands deposits are known in the provinces of Nova Scotia and New Brunswick. Production is not large and serves a limited market. Parallel programs under the geoscience and technical sectors of the MDA's, both federal and provincial, will identify and assess the properties of deposits for which this information does not already exist. The determination of resource capability to meet demanding market requirements should maximize opportunities for the development of silica and silica sands resources in Nova Scotia and New Brunswick.

3. SCOPE OF WORK:

3.1 Determine and quantify markets for silica and silica sands reasonably accessible from Nova Scotia and New Brunswick sources.

(a) Identify silica and silica sands consumers by industry noting specifications required, quantities used, current suppliers, prices paid for various types of barite by each industry, transportation modes and costs, packaging types and costs; function(s) performed in each application, substitute materials and their relative performance and costs.

(b) Document corporate purchase arrangements between suppliers and consumers for the various user industries.

(c) Indentify opportunities for market penetration with acceptable material, areas where cost savings would be significant and where the consumer industry would be sensitive to such cost savings.

3.2 Estimate demand for silica and silica sands within the study area by consumer-industry to the year 2005 and estimate reserves of present suppliers.

(a) Provide indicators and describe the methodology used to arrive at estimates and indicate confidence levels.

(b) Describe major changes forseen in consumption patterns, by industry.

(c) Determine effects of new methods of production and processing on consumption sectors and on costs.

(d) Determine how changes in user specifications could alter the resource base.

3.3 Address other factors which could advance further information pertinent to the identification and development of markets for silica and silica sands, factors not included within (1) and (2) above and of which the selected Contractor is aware by virtue of his knowledge of this field of activity.

APPENDIX 2

DESCRIPTIONS OF INDUSTRIAL SAND AND GRAVEL MARKETS IN THE UNITED STATES AND CANADA

MAINE
INDUSTRIAL SAND AND GRAVEL

No industrial sand and gravel is mined in Maine. Maine is a large producer of garnet, which is used as an abrasive and for filtration, heavy media, sandblasting, filtration sand, and nonskid, wear-resistant coatings.

NEW HAMPSHIRE
INDUSTRIAL SAND AND GRAVEL

Industrial sand and gravel is not produced in New Hampshire.

VERMONT
INDUSTRIAL SAND AND GRAVEL

Industrial sand and gravel is not produced in Vermont.

MASSACHUSETTS

INDUSTRIAL SAND AND GRAVEL

Production:

Two companies produce industrial sand in Massachusetts: Holliston Sand Co. Inc. in Middlesex County, and Whitehead Bros. Co. in Plymouth Co.

Production figures are available for only two years: 1981 (0.087 M short tons) and 1982 (0.140 M short tons). The 1982 production was worth $1.6 M.

Value:

The only average unit value available for industrial sand and gravel is the 1982 figure of $11.56 per short ton.

Consumption:

Industrial sand is sold primarily to foundries.

Alternate materials:

Nonmetallic crude artificial abrasives are manufactured by Norton Co. of Worcester. They are used for the housing, furniture and automobile industries.

RHODE ISLAND
INDUSTRIAL SAND AND GRAVEL

Production:

Industrial sand has been produced in Newport and Providence counties. In 1982, the only year of record, five thousand short tons were produced, valued at $52 000.

Value:

In 1982, the average unit value of industrial sand was $10.00. In 1981, it was $3.00. No unit values are available for 1983 or 1984.

Consumption:

The main uses for Rhode Island's industrial sand are molding and foundry applications.

CONNECTICUT

INDUSTRIAL SAND AND GRAVEL

Production:

In 1982, three companies produced industrial sand, in 1983 the number was two. The two firms were Feldspar Corp. of Middlesex County and Ottawa Silica Co. of New London County.

In 1982, 0.08 M short tons of sand was produced, worth $1.7 M.

Value:

Industrial sand receives a relatively high price in Connecticut as shown below:

1984	--
1983	$33.58 per short ton
1982	$21.84
1981	$25.67

Consumption:

It is not known for what the state's industrial sand is used.

NEW YORK

INDUSTRIAL SAND AND GRAVEL

Production:

Only one company, Whitehead Bros. Co., produces sand in New York. It has pits in Saratoga and Oneida Counties.

Production data is available on only two years--1981 (0.055 M short tons) and 1982 (0.045 M short tons). The value of 1982 production was $0.5 M.

Value:

Average unit value figures are available for two years--1982 ($11.45 per short ton) and 1983 ($11.45 per short ton).

Consumption:

The industrial sand is used for moldings and foundry uses.

Alternate materials:

Abrasives are manufactured in New York (Niagara Falls). The materials are aluminum oxide, wire shot, and alpha silicon carbide.

NEW JERSEY
INDUSTRIAL SAND AND GRAVEL

Production:

New Jersey is a leading producer of industrial sand in the United States. In 1984 it ranked third in production. Presented below are production values for 1981-1984:

1984	2.8 M short tons	$36.8 M
1983	2.4	$31.8
1982	2.1	$28.2
1981	2.3	$26.4

Cumberland County accounts for over 95 percent of state production with the rest coming from Gloucester, Ocean, and Middlesex counties. Principal producers are:

New Jersey Silica Sand Co. - Cumberland (dredge)
Pennsylvania Glass Sand Corp. - Cumberland (dredge)
Whitehead Bros. Co. - Cumberland (1 dredge, 1 pit)
Jessie S. Morie and Son - Cumberland Co. (2 dredge, 1 pit)

Value:

Average unit value for industrial sand has held steady through the 1980s:

1984	$13.18 per short ton
1983	$13.33
1982	$13.15
1981	$11.47

Consumption:

The principal uses of sand produced in the state are glass products, foundry cores and molds, refractories, sandblasting, and filtration.

New Jersey is the fourth leading state in terms of glass production following California, Pennsylvania and Indiana. The glass plants are clustered in the south (see Table 1).

There is an extensive export market for the state's high silica sand, especially for filtration.

James M. Ronan Associates Inc. used cultured quartz crystal at its Wayside, Monmouth Co. facility for electronic products.

TABLE 1 - GLASS PLANTS IN NEW JERSEY
(U.S. BUREAU OF MINES MINERALS YEARBOOK)

PLANT	LOCATION
Kerr Glass Manufacturing Co.	Millville, Cumberland Co.
Owens-Illinois Inc.	Vineland, Cumberland Co.
Wheaton Industries	Vineland (largest plant in state)
Anchor Hocking Corp.	Salem, Salem Co.
Durand Glass Manufacturing Co.	Millville (new plant 1983, French owned)
Driver-Harris Co.	Hudson Co.
Kontes Glass Co.	Bridgeton, Cumberland Co. (purchased by Owens-Illinois, 1982)

PENNSYLVANIA

INDUSTRIAL SAND AND GRAVEL

Production:

While figures are not available, it is known that industrial sand production decreased in Pennslvania in 1983 and 1984. In 1982, 0.97 M short tons was produced, worth $13.6 M. The figures for 1981 were not available, but the quantity was similar to 1982.

In 1982, there were four producers in Pennsylvania:

- Airport Sand and Gravel Co. Inc., Luzerne Co. (one deposit)
- Glacial Sand and Gravel Co., Armstrong Co. (one deposit)
- McGrady Inc., Allegheny Co. (two deposits)
- Pennsylvania Glass Sand Corp., Huntington Co. (two deposits)

Three companies produced cultured quartz crystal in 1983. They were Bliley Electric Co., Erie, Motorola Inc., Carlisle, and P.R. Hoffman Co. Carlisle. The feed material is lasca, a nonelectronic grade quartz. The crystals were used by several firms in the State (see Table 1). Crystal is used for watches, clocks, televisions, and radios.

Value:

Presented below are average unit values for 1981 to 1983:

1983	$14.32 per short ton
1982	$14.02
1981	$13.18

Figures are not available for 1984.

Consumption:

The main use for industrial sand produced in Pennsylvania is glass products. Other uses are molds and cores (foundry), refractories, and fillers. The preferential use of plastic containers over glass has reduced demand for industrial sand.

Silicon carbide is produced in Pennsylvania by Satellite Alloy Corp. of Springdale (nonabrasive application).

Alternate materials:

Tripoli, also known as rottenstone, is a decomposed siliceous limestone. It is mined in Pennsylvania and used as an abrasive and filler.

TABLE 1 - CONSUMERS OF CULTURED CRYSTAL IN PENNSYLVANIA
(1982, U.S. BUREAU OF MINES MINERAL YEARBOOK)

COMPANY	LOCATION (COUNTY)
Anderson Electronics Inc.	Blair
Dynamics Corp. of America	Cumberland
Erie Frequency Div. of Erie Technological Products	Erie
McCoy Electronics Co.	Cumberland
J. K. Miller Co. Inc.	Allegheny
Piezo Crystal Co. Inc.	Cumberland

MARYLAND

INDUSTRIAL SAND AND GRAVEL

The only producer of industrial sand in Maryland is Harford Sands Inc. of Magnolia. No information is available on its production, value or customers. It is estimated that under 0.25 M short tons of silica were produced.

DELAWARE

INDUSTRIAL SAND AND GRAVEL

There is no industrial sand and gravel produced in Delaware.

VIRGINIA
INDUSTRIAL SAND AND GRAVEL

Production:

Information about Virginia's industrial sand and gravel production was withheld in 1981-1984. It is estimated that 0.9 M short tons of silica were produced in 1982. It is known that the state has three producers: Unimin Corp. at Gore, Frederick County (mine and flotation plant), J. C. Jones Sand Co., Inc. at Virginia Beach and Saltville Silica, Smyth County.

In 1984 United Fibreglass commenced production of home insulation at Woodbridge, Prince William County. Its silica comes from West Virginia.

Value:

No average unit value was given in 1984. For other years the values were:

1983	$10.64 per short ton
1982	$11.74
1982	$ 7.50

Consumption:

The following are the uses for industrial sand and gravel produced in Virginia:

glass	Unimin Corp.
casting and traction medium	J. C. Jones Sand Co.
glass (Tennessee)	Saltville Silica

CED Process Minerals Inc. processes industrial sand. Final use is unknown.

Alternate Minerals:

Kyanite is produced in Virginia. It is an aluminum silicate used in refractories and ceramics.

Aplite, a feldspar-mineral is also produced. It is used in glass manufacturing but should not compete with silica sand.

NORTH CAROLINA

INDUSTRIAL SAND AND GRAVEL

Production:

Industrial sand and gravel experienced a large decline in volume of production in 1982 (73 percent) and has yet to recover to 1981 levels. Total production (sand and gravel) figures:

1984	1.07 M short tons	$11.78 M
1983	1.07	$11.79
1982	0.72	$ 4.9
1983	1.24	$10.4

North Carolina has a large industrial gravel industry which represents 30-50 percent of total production. The gravel production figures were:

1983	0.37 M short tons	-
1982	0.29	$ 2.7 M
1981	0.60	$ 4.8 M

State sand and gravel production comes from three areas: the Anson-Richmond County area (south-central) which represents 75-80 percent of production, Cleveland County (second in production) and Harnett County. The Cleveland output is a coproduct from a mica production. In addition, International Minerals and Chemican Corp. (Mitchell County) produces a high purity, electronic grade product using silica from their alaskite beneficiation operation.

In 1984, Wheaton Industries commenced production of a new glass container plant at Norwood-Carolina. Also Libby-Owens Ford Co. announced that its glass coating, heat treating, and insulating

glass fabrication facility was for sale. It is located in Clinton. Unimin, Marston announced plans to expand its silica flour operation. The flour is used to produce flour for chemical and fibreglass.

Value:

Average unit values of industrial sand and gravel have varied greatly during the 1980s. Gravel is generally a higher valued product than sand.

Year	Sand*	Gravel*	Overall*
1984	--	--	$10.92
1983	--	--	$10.97
1982	$5.09	$9.33	$ 6.81
181	$8.78	$8.09	$ 8.44

* values are per short ton

Consumption:

Principal uses for industrial sand produced in North Carolina are glass container manufacture, sandblasting, and filtration. However, over 80 percent of the sand is used for "other" uses.

Industrial gravel is used for ferrosilican applications and "other".

Alternate materials:

Feldspar and pyrophylite are mined in the state. While used for glass and refractory manufacture, they should not represent competition for silica.

SOUTH CAROLINA
INDUSTRIAL SAND AND GRAVEL

Production:

After a drop in 1982, industrial sand production has increased steadily in South Carolina.

1984	0.88 M short tons	$14.6 M
1983	0.84 M short tons	$13.2 M
1982	0.72 M short tons	$10.9 M
1981	0.80 M short tons	$10.5 M

Production is located in the central and north central part of the state (Lexington and Kershaw Counties). There, five companies operate seven pits. A major producer of ground silica is Pennsylvania Glass Sand (PGS) Corp. In 1984, PGS announced plans to expand its ground silica plant in Columbia (100-400 mesh).

Value:

Average unit values for industrial sand have increased throughout the 1980s, as illustrated below:

1984	$16.71 per short ton
1983	$15.64
1982	$15.14
1981	$13.11

Consumption:

Principal uses for the industrial sand include glass containers, fibreglass, molds and cores.

GEORGIA

INDUSTRIAL SAND AND GRAVEL

Production:

Presented below are production figures for industrial sand in Georgia:

1984	0.45 M short tons	$6.4 M
1983	0.54 M	$7.3
1982	0.54 M	$6.8
1981	withheld	withheld

In 1982 there were six operations in six counties; in 1983 there were four operations in four counties. The counties were Crawford, Greene, and Macon in centre and Thomas in the southwest.

Value:

The average unit value of industrial sand has increased through the 1980s:

1984	$14.29 per short ton
1983	$13.55
1982	$12.55
1981	withheld

Consumption:

The three principal uses of industrial sand in Georgia are, in order, glass container manufacturing, sandblasting, and roofing granules. Other uses include filtration and mold sand cores.

Alternative Materials:

Silicon carbide is produced in Georgia. Silicon Metals Inc. recovers the material from a sludge at a granite cutting and finishing operation (Elberton). Froth flotation is the separation technique used.

Two types of aluminum silicate--feldspar and kyanite--are mined in Georgia. They are used in glass, ceramic and refractory manufacture.

FLORIDA

INDUSTRIAL SAND AND GRAVEL

Production:

Florida's industrial and gravel production has remained steady during the 1980s as illustrated below:

1984	0.35 M short tons	$3.7 M
1983	0.33*M	$3.4*
1982	0.34 M	$4.3
1981	0.35 M	$4.4

Six companies produced industrial sand -- one as a byproduct from Kaolin operations.

Value:

The average unit value of industrial sand took a drop of 16 percent in 1983, but recovered in 1984.

1984	$10.68 per short ton
1983	$10.48*
1982	$12.48
1981	$12.66

Consumption:

Prime uses for industrial sand are glass manufacture and foundry castings. Markets included Alabama, Florida and Tennessee.

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*In 1983 2000 short tons of gravel were produced, worth $30 000. Rest was sand.

Competing minerals:

Florida produces staurolite as a by-product of ilmenite processing. Staurolite is an iron-aluminum silicate low in free silica used for cement, foundry applications and sandblasting.

Zircon is produced as a by-product of mineral sands production. It is used for ceramics, foundry applications and refractories.

ALABAMA
INDUSTRIAL SAND AND GRAVEL

Production:

Alabama produced 0.51 M short tons of industrial sand and gravel in 1984. The value of production was $4.5 M. Production for the three previous years was:

1983	0.42 M short tons	$4.4 M
1982	0.96	$8.1
1981	0.18	$0.9

There were seven producers in Alabama in 1983, down one from 1982. All operations were small, producing less than 0.20 M tons each.

Value:

The average unit value of industrial sand and gravel has fluctuated throughout the 1980s:

1984	$6.93 per short ton
1983	$7.78
1982	$8.43
1981	$4.75

Consumption:

The primary use of industrial sand and gravel was for molds and cores. However, there was one quartzite pit operated by the Globe Metallurgical Div. of Interlake Inc. which produced gravel for silicon alloy.

Alternate materials:

Artificial abrasives were manufactured in Madison County. Norton Co., Huntsville, manufactured high-purity aluminum oxide.

MISSISSIPPI
INDUSTRIAL SAND AND GRAVEL

Production:

Figures for industrial sand and gravel production in the state have been withheld to avoid disclosing company proprietary data. It is estimated that 35 000 short tons were produced in 1982. According to the U.S. Bureau of Mines, two companies produce industrial sand in the state. One company is in Jackson County; the other in Tishomingo Counties.

Value:

In 1983, the average unit value of industrial sand was $12.87; in 1982 it was $13.41.

Consumption:

Industrial sand produced in Mississippi is used for sandblasting, molds, and cores.

LOUISIANA

INDUSTRIAL SAND AND GRAVEL

Production:

Louisiana's production of industrial sand has fluctuated about 0.30 M short tons during the 1980s:

1984	0.30 M short tons	$4.3 M
1983	0.29	$4.3
1982	0.38	$4.6
1981	0.29	$4.0

Material is produced by three companies in four parishes with East Baton Rouge being the leader, followed by Webster, Allen and Red River.

Value:

Through the 1980s, the average unit value for industrial sand has varied as follows:

1984	$14.33 per short ton
1983	$14.61
1982	$12.14
1981	$13.74

Consumption:

Primary markets for industrial sand are glass factories and foundries.

TEXAS

INDUSTRIAL SAND AND GRAVEL

Production:

Texas is one of the largest industrial sand producing states in the United States, ranking third or fourth through the 1980s. Production has varied substantially through the 1980s:

1984	2.2 M short tons	$32.4 M
1983	1.8	$29.6
1982	2.6	$45.0
1981	2.2	$37.0

In 1982 there were sixteen deposits worked in five counties; in 1983 seventeen pits in ten counties. McCulloch County is the leading county--in 1983 it accounted for almost 40 percent of total state production. Other producing counties include Colorado, Johnson, Limestone, and Harris.

Major companies include:

Company	Location	Use
NOWSCO	Longview	fracturing
Vulcan	Brady (McCulloch Co.)	0.5 M short tons fracturing
Kerr Glass Manuf. (purchase from Unimin)	Cleburne (Johnson Co.)	glass
Texas Mining Co.	Brady (McCulloch Co.)	blasting, fracturing, filtering of pipe products

Pennsylvania Glass Sand Corp.	Voca (McCulloch Co.)	fracturing (75%), foundry, abrasive

Value:

Industrial sand average unit values dropped substantially in 1984:

1984	$14.73 per short ton
1983	$16.58
1982	$16.34
1981	$16.50

The drop in demand for fracturing sand has resulted in a large drop in value: at the end of 1983 unit value was $16 per ton, in October it had been $20 and in September 1983, $30.

Demand:

The leading uses of Texas' industrial sand are: fracturing, blasting, glass containers, ground fibreglass, and sheet glass.

Transportation:

Over 80 percent by truck, rest by rail.

QUEBEC

INDUSTRIAL SAND AND GRAVEL

Production:

Quebec is traditionally the number two producer of silica in Canada, although it ranked first in 1982. Over the last few years production has remained steady, between 600-700 kilotonnes per year (see below).

1982	661 kilotonnes	$12.7 M
1981	694	$13.0
1980	703	$11.0
1979	607	$ 8.9

Production value has increased steadily, reflecting price increases.

There are six producers of silica in Quebec:

Armand Sicotte & Fils Ltée, St. Hubert
Electro-Metallorgie (SKW Canada Limitée), Montréal
Les Mines de Silice Montréal Ltée, Montreal
Mines Lorna Lily Inc., Montréal
Societé Minière Melocheville Limitée, Melocheville
Indusmin Limited/Limitée, Montréal

All but Indusmin are small.

Value:

Average unit value figures were:

1982	$19.21 per tonne
1981	$18.73
1980	$15.65
1979	$14.66

Consumption:

In Quebec, silica is used for foundry sand, flux, glass and silican carbide production.

ONTARIO

INDUSTRIAL SAND AND GRAVEL

Production:

Ontario has historically ranked first in Canada in the production of silica. In 1982, however, it fell behind Quebec. Production dropped every year from 1979 to 1982:

1982	438 kilotonnes	$ 8.2 M
1981	901	$11.0
1980	936	$ 9.6
1979	980	$ 9.0

Value of production rose until 1981, due to a rise in unit prices. In 1982, value dropped despite an increase in unit prices.

There are only two silica producers in Ontario:

Indusmin Limited/Limitée, Toronto

International Minerals & Chemical Corporation of Canada Ltd., Havelock

Indusmin in the largest by far.

Value:

Average unit values for 1979 to 1982 were:

1982	$18.72 per tonne
1981	$12.21
1980	$10.26
1979	$ 9.18

Consumption:

The main uses of silica in Ontario are glass, foundry sand, flux, and silicon carbide production.